

AN ESSAY.
TOWARDS A
SYSTEM OF MINERALOGY.

By AXEL FREDERIC CRONSTEDT,
MINE-MASTER OR SUPERINTENDANT OF MINES IN SWEDEN.

TRANSLATED FROM THE ORIGINAL SWEDISH,
WITH ANNOTATIONS, AND AN ADDITIONAL TREATISE ON
THE BLOW-PIPE.

By GUSTAV VON ENGESTROM,
COUNSELLOR OF THE COLLEGE OF MINES IN SWEDEN.

THE SECOND EDITION,
GREATLY ENLARGED AND IMPROVED, BY THE ADDITION
OF THE MODERN DISCOVERIES; AND BY A NEW
ARRANGEMENT OF THE ARTICLES,

By JOHN HYACINTH DE MAGELLAN,
TALABRICO-LUSITANUS, ET REG. SOC. LONDIN. ACADE-
MIARUM IMP. SCIENTIAR. PETROPOLIT. ET BRUXELL.
REG. ULISIPON. MADRIT. ET BEROLIN. SOCIET.
PHILOS. PHILADEL. HARL. ET MANCHEST. SOCIUS;
ET ACAD. REG. PARIS. SCIENTIAR. CORRESPONDENS.

IN TWO VOLUMES.

V O L. I.

L O N D O N,
PRINTED FOR CHARLES DILLY, IN THE POULTRY.
M DCC LXXXVIII.



T O

COUNT L O U I S

DE BARBIANO DE BELGIOIOSO,

KNIGHT OF THE ORDER OF MALTA,

ACTUAL CHAMBERLAIN

AND PRIVY COUNSELLOR OF STATE

TO HIS IMPERIAL AND ROYAL MAJESTY,

LIEUTENANT GENERAL OF HIS ARMIES,

AND PROPRIETOR OF A REGIMENT

OF INFANTRY

IN THE IMPERIAL TROOPS, &c. &c. &c.

THIS IMPROVED ESSAY,

TOWARDS A SYSTEM OF MINERALOGY,

IS,

WITH THE GREATEST RESPECT AND

GRATITUDE,

INSCRIBED,

BY HIS MUCH OBLIGED,

AND VERY HUMBLE SERVANT,

J. H. DE MAGELLAN.

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THE
EDITOR's
P R E F A C E.

THE great superiority of Cronstedt's Mineralogical System, when compared with every attempt of the kind before published, is universally admitted. I have always esteemed it a fortunate circumstance, that I met with it in the commencement of my acquaintance with this branch of knowledge, and am greatly indebted to the friendship of Mr. Engestrom, who first recommended it to my attention. This Gentleman, who was formerly a pupil of the illustrious Author, brought with him a copy of the first edition of this work, published in Swedish in 1758, when he visited this capital. In a variety of conversations with him on the subject, I was strongly impressed with the solidity of judgement in which the system is founded: and I earnestly entreated him to translate it into English, for the advantage of the public. He complied with this
a 3 request,

request, and the translation was printed in 1770.

This treasure of Mineralogical knowledge was gladly received; and in a short time the edition was exhausted. The Proprietor, who knew my attachment to the subject, applied to me to superintend a second edition, to which proposition I immediately acceded, without any view to pecuniary emolument. My intention was to add, by way of Notes, the chief discoveries and improvements that have been made since the Author's time. Mr. J. Fabroni, whose great skill in Mineralogy and Chemistry is well known, and who is at present employed in arranging the celebrated collection of his Royal Highness the Grand Duke of Tuscany, was then in London, and very kindly obliged me with various accounts of the new improvements in these sister-sciences, written in the French language. A very obstinate complaint of violent pains in the head and eyes, with which I was at that time afflicted, prevented me from proceeding; but it gave me the utmost pleasure, in this distressing situation, that Mr. Kirwan, to whom I mentioned it, undertook to have Mr. Fabroni's Notes translated into English, and to add such facts as might occur to him for the information of the public. The undertaking was in this state when I visited the continent, chiefly with a view to consult about the cure of the complaint I was afflicted with. I was happy enough to succeed, and returning after an absence of near two years,

years, I found that Mr. Kirwan had been prevented, by various accidents, from accomplishing his promise. He returned the original papers with very few new pages of the Notes in English; and some time afterwards acquainted me with his intention of publishing a summary view of Mineralogy. This was actually published in 1784, under the title of *Elements of Mineralogy*, and has with justice been highly esteemed by the public. The event, however, instead of being a check to my second edition of Cronstedt's Mineralogical Essay, has rather encouraged my zeal to avail myself of the contents of Mr. Kirwan's performance (with his consent), which may be considered as a very valuable improvement of the present work.

Upon mature reflection, I was convinced that my original intention of retaining the order which the Author had adopted in his System, could not be adhered to without a manifest confusion of the whole. *If, as the great Bergman observes, the Author had lived longer for the benefit of the Sciences, he would no doubt have rectified the disposition of his Mineralogical System.* For without mentioning other numerous discoveries, it has been well ascertained some years ago, that there are but five primitive Earths, instead of the nine described by the Author, most of which are mere compounds of the former; the Ponderous Earth was unknown in his time, though its existence as a peculiar substance was suspected by him;

and the Magnesian Earth was almost equally unattended to. I was therefore obliged of course to give the whole under a new arrangement, placing the several Sections of the Author under such Orders and Genera, as the improved knowlege of later times dictated, as will be seen on consulting the work; but I have, at the same time, been careful in changing only the places of the Sections, to leave the matter unaltered nearly as it stood in the first edition, and at the head of every Section I have added either its number according to the first arrangement, or have mentioned that it is additional or altered as the case may be. Besides which, I have prefixed a Table of Contents of the original order, that the Reader may see the whole at one view, and more readily compare it with the order I have adopted.

The number of Sections in the present edition amount to 443, occupying 923 pages, with many Notes, great part of which are of importance, and every one either founded on facts within my own knowledge, or extracted from Authors of the first reputation. The Sections of the former edition were only 300, and were printed in 272 pages, not nearly so full as the pages of the work now presented to the public. The Treatise of M. Eugeström on the Blow-pipe and Pocket Laboratory, first published with this work, but since translated into almost every European language, is also reprinted at the end of this Mineralogy, with Notes from Bergman, and two short Appendices,

dices are subjoined, one containing a description of the travelling apparatus for the *dry* and *humid assays*, and of the *Lamp Furnace* used by the celebrated Professor Bergman, for chemical experiments, on a small but advantageous scale, which was first published by M. de Morveau, and is now greatly improved; the other consisting of the method of assaying earths and stones, extracted from Kirwan's Elements of Mineralogy; the description of a new instrument contrived by Mr. W. Nicholson, for ascertaining specific gravities; and lastly, a new method of my own, for making general weights with the greatest ease and accuracy.

I am persuaded, that such as are acquainted with the improved state of Mineralogy, will approve of the method I have adopted, in preference to the numerous and often contradictory notes which would otherwise have been required to settle the several matters in their proper order. To arrange the most important facts in an advantageous manner, has been the only aim of my labour, imperfect as it may be. I have not been actuated by the vanity of pretending to be the Author of a System, nor to instruct the most accomplished Mineralogists of our age. I have used none of the artifices of book-makers: I have, without hesitation, availed myself of every help I could procure; but I have been equally ready and careful to name all my authorities, as well for the obvious advantage of authenticity, as that I might not insidiously derive fame from the labours of others. Those who are as ignorant of the subject

ject as I have formerly been, may, I flatter myself, receive great advantage from this performance, by saving the labour and time I was obliged to bestow, in acquiring an acquaintance with the modern discoveries. I have done whatever lay in my power to render it complete, notwithstanding the variety and multiplicity of my other avocations, which did not allow sufficient time to reconsider and revise my manuscript before it went to the press. I have not, however, neglected to employ a proper person to correct the language, which otherwise would have been scarcely proper for the public eye, as I am myself a foreigner, who came to England at an advanced age. In whatever manner the numerous kinds of readers, which compose the heterogeneous mass called the Public, may decide concerning my labours, I shall rest contented with that approbation, which the uprightness of my intentions may justly claim. Not at all agitated with hopes, either of a pecuniary or even honorary nature, I am already in possession of that satisfaction which a sincere, though perhaps weak exertion to promote the public good, cannot fail to produce in a well-disposed mind. Convinced that, at least so far, I shall have the worthy and estimable part of mankind on my side, I can with ease overlook the efforts of the malignant, which, though they may excite compassion and contempt, are hardly of importance enough to produce any other emotion.

London, 1788.

T H E
T R A N S L A T O R ' s
P R E F A C E.

THIS Essay was published in Swedish in the year 1758, by the Author, who in the beginning chose to be anonymous, for reasons he has given in his Preface: He could not, however, remain long concealed, but was soon discovered to be the learned nobleman Axel Fredric Constedt. I now give a translation of it, to comply with the desire of several of my friends here in England. I shall not attempt to amuse the Public in favour of this work, since it speaks so well for itself, and has been almost generally adopted wherever known.

The universal applause, and the favourable reception it met with in Sweden, made it soon known in Norway and Denmark. In the year 1760 it was translated into German, and was equally approved in Germany; nor, indeed,
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has it been unknown to the learned in England; for the ingenious and celebrated Dr. Lewis has mentioned it with praise in the second part of his *Philosophical Commerce of Arts* lately published.

As a foreigner I should make an excuse for the translation, it not being so elegant as it ought to be; however, I flatter myself I shall not be too severely censured on that account, since it is a known truth, that originals always lose something of their beauty by being translated: I therefore think it better to prefer the true meaning of Authors to the elegance of style, particularly in scientific works; and I am in this respect more able to give the Public satisfaction, as I have had the happiness to be a disciple of the Author himself.

That the mineralogical terms might be more generally understood, I have added the Swedish and German names of the mineral bodies to their English and Latin names; except when, to avoid tautology, I have sometimes left out the German, as nowise different from the Swedish names. New discoveries being daily made in this science, I have also added some notes of my own, concerning such things of which I am perfectly convinced, leaving several others to be further examined and tried.

I was in hopes to have seen a second edition of this excellent work improved and augmented by the Author himself; he having, ever since the first publication of it, been constantly

stantly employed in making further enquiries and discoveries in this science: He had even actually made some collections towards it, of which, however, the literary world is likely to be unfortunately deprived, as he lately died in the fortieth year of his age, before he had time to revise and put his new observations in due order.

T H E
A U T H O R'S
P R E F A C E.

AS former ages principally encouraged philological and antiquarian enquiries; this present age, at least in Sweden, favours the study of Natural History.

Such changes must be ascribed to geniuses, who understand how to make those sciences, which they have chose for their principal study, agreeable to the Public; and which sciences, being in general useful to the whole community, every individual thereof can reap some advantage from it, and thereby gratify that self-love implanted in the breast of all mankind in the pursuit of them.

When the pride of a nation is flattered with the vain glory of being of great antiquity, the author of such an opinion is always favoured; and every little circumstance conducive to further confirm it, is carefully recollected and noted. Thus when the subjects of the creation
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are represented to us in a manner which assists our memory, and renders our conceptions of them easier, we aim at earnestly adopting the noble improvement, and, in order to be the more esteemed, we likewise always confer praise on the Author.

As long as the Author adheres to his system, and does not alter it, but only illustrates it from time to time with some additional observations, we are not only well satisfied with him, but also often become his faithful assistants. But if he, convinced of the impropriety of his method from its very principles, rejects it, and presents us with another new and entirely different; what will then be the result? Or what is likely to happen if this is attempted by a person who is unknown, and not artful enough to seize on the advantages of our passions?

For my part, I am apt to believe that, in the former case, the present general taste might be somewhat lessened without any loss to the science itself; because among the great number that love Natural History, there are always some who embrace it when free from errors, and others, who are only fond of new reasonings and conclusions, merely because they are so.

These latter are even of service, and their party will certainly increase in length of time.

From this persuasion I have ventured to publish this Essay for treating Mineralogy in a systematical manner; a study to which I have with so much pleasure applied myself. It is not done with the desire of novelty; and still less

less from contempt of those systems, which Swedish gentlemen in particular, very deservedly, though chiefly on the same principles, have heretofore generally pursued.

I have thought proper to conceal my name*, to prevent any constraint on myself or others, and with a view to be at a greater liberty to amend the system, whenever I shall be convinced there is a necessity for so doing, either by my own experience, or by the observations of others: For I flatter myself that this work will not pass unnoticed by men of letters; and, as it is only an Essay, it ought, according to an established law amongst authors, to be sheltered from too severe censures.

I wish that the mineralogists themselves would examine and compare all that has been hitherto done in this science; they would then find the reason which has induced me to deviate from the received systems, and to propose another founded upon my own, as well as upon the discoveries of others. But as this comparison is not in the power of every one to make, I think it necessary briefly to repeat here the changes which this science has undergone.

The first writers on Natural History found so great a number of unknown bodies before them, that their curiosity and time would not allow them to do more than to describe them by their mere external appearances, and to collect the names by which they were known to the natives of the countries where they were

* Mr. Cronstedt never put his name to this Essay. D. C.
found.

found. But as every country had a different name for these bodies, they often gained more names than there were real species, and even sometimes the very reverse happened; this occasioned a confusion, which in the beginning was excusable, but in length of time could not fail of being an obstacle to the progress of the science, and its application in common life.

To remove these inconveniences, they have in later and more enlightened times endeavoured to fix proper names to the subjects of the mineral kingdom, according to their external marks, as in regard to Figure, Colour, and Hardness; but these characters afterwards having been found not sufficient, it was necessary to discover others more solid by the result of chemical experiments, which added to the former ones would make a complete system. Hiarne and Bromell were, as far as I know, the first who founded any mineral system upon chemical principles. However, they were only the projectors of this manner of proceeding; and to them we owe the three known divisions of the most simple mineral bodies; viz. the *Calcarei, Vitrescentes, et Apyri*. This system was afterwards adopted by Dr. Linnæus, who, as a very skilful person in the other two kingdoms of nature, ought not to have omitted the third when he published his *Systema Naturæ*. Browal, bishop of Abo, a prelate of great learning, had an opportunity of altering and improving Linnæus's method in a manuscript, which Dr. Wallerius has since made public in his *Mineralogy*,

logy, with some alterations of his own; however, the principal foundation remained the same in all, or according to Bromell's method, which he had published in a small book, entitled *Indications for the searching for Minerals*. But at length Mr. Pott, a chemist by profession, and consequently inclined rather to trust to the effects of his experiments, than to the external appearances alone, proceeded farther than was customary before his time, in the assaying of stones by fire, and afterwards published his acquired knowledge by the title of *Lithogognesia*. From this book the said author received considerable honour, because the true advantage of his researches began to appear: Miners and others manufacturers were by it able to determine the reason of certain effects, which they either did not observe before, or wilfully concealed, to avoid the censure of being ignorant, if they advanced such things as real truths, which, according to modern systems were regarded as contradictory and absurd. Mr. Woltersdorff, a disciple of Mr. Pott, then began *immediately to form an entire mineral system*, founded upon chemical experiments; but his master did not approve of it, still insisting that materials were yet wanting for the purpose: and that *every* mineral body ought first to be examined and tried with the same care that he had tried and examined the most simple of them; to wit, the Earths and Stones.

Such was, according to the idea I had of it, the state of Mineralogy, when I, from a sense of the

the difficulties which beginners laboured under, undertook to put my scattered thoughts in this order. Naturalists agreed with me, in thinking the barrier, which had long been defended with such ardour, was now beaten down, and that it was necessary another should be erected in its stead, as good as could be procured, until a perfect one might be in time discovered.

Such an enterprize it was thought would promote this desirable end, when on the one side I reflected upon the passion which our learned men have for disputing, and on the other part considered the gracious reception which the Arts and Sciences have met with at this time, from those to whom the heavy burthen of governing human societies is allotted. It is from their care we are to expect the compleat tribunal where all disputes in this matter can be accurately decided, and all things be rendered truly useful; I mean, the institution of a Laboratory; where the sight, grinding, and polishing; where the air, liquid, and dry dissolvents, and also fire in all its degrees, from the electrical to that of the burning-glass, may be employed as means to obtain the knowledge of these intricate and unknown bodies.

To a similar circumstance, perhaps, those chemical experiments upon vegetables were owing, which were made many years ago in a certain kingdom; and though they did not answer at that time the intended purpose, yet they may at some future time be repeated with

advantage, when more knowledge in that matter is obtained: But thus much we certainly know by experience, that the mineral kingdom is extremely well adapted to be examined by these means. The experiments made by the ingenious Mr. Homberg, with Tschirnhausen's burning-glass, may certainly be carried yet farther, whereby some doubts may likewise be removed, which still remain, respecting some of the effects of his experiments. Thus, we should be employed in observing the phenomena and drawing conclusions from them, instead of only searching for the principles of those effects, as naturalists were formerly obliged to do.

How satisfied would every lover of systems be, if by this means he could get materials properly prepared to compose a better work, in which he could introduce the few valuable things which are to be found among the old ruins, and leave out all the vague expressions, together with the distinctions, that are of no consequence!

When I had, for the above-mentioned purpose, collected my own observations, and those of others, I heard of two new books on the same subject; they were Mr. D'Argenville's *Oryctology*, and Mr. Justi's *Mineralogy*; for which reason I laid my manuscript aside, until I had, by the perusal of those two works, convinced myself that those gentlemen had not prevented me from pursuing my plan; for, the former has, in my opinion, endeavoured to bring

bring us back to a taste that was formerly in vogue; and which, though we do not despise, yet *we neglect*. The second seems to have hurried himself too much, mixing together some irresistible truths, with a greater number of opinions not yet demonstrated, or mere conjectures; *which is running on faster with a theory than experiments will permit*; whereby nature, which is the *chief point*, will at the end be lost.

Therefore, that no fondness for novelties, in consequence of these new works, or others of the like nature which may hereafter be published, may again divert our attention from the *only method of obtaining any knowledge of the Mineral Kingdom*, which has with so much pains at length been discovered, and has already been a little entered upon; I have, prompted either by self-love, or a more generous motive, published this Essay, even before I have had time and leisure to reduce it into a perfect system: I do not pretend that it is a compleat one, by which we can with certainty divide mineral substances, and afterwards reduce them into order. I have chiefly intended it as a bar or opposition to those who imagine it to be an easy matter to invent a method in this science, and who, *entirely taken up with the surface of things*, think that the *Mineral Kingdom may with the same facility be reduced into classes, genera, and species*, as *animals and vegetables* are; they do not consider that in the two last kingdoms of nature there are but seldom, and never more than, two different kinds

found mixed together in one body; whereas in the mineral kingdom it is very common, though it will nevertheless always remain concealed from every one, however penetrating, *who has not employed himself in the compounding or de-compounding such bodies*, as far as the present knowledge of these matters will permit.

So much may be said in general concerning this Essay; but now I ought more particularly to inform my readers of the motives why I have now and then deviated from the orders and distinctions hitherto used.

Earths and Stones are comprehended in one class, because, 1. they consist of the same principles; 2. they are by turns converted from one into the other, insomuch that an earth may in length of time become as hard as a stone, and *vice versa*: nor can the true difference between a stone and an earth be positively pointed out by the degrees of hardness or softness; for where is it that the common chalk finishes, and the lime-stone begins, in the English strata? and how is a clay, whether in water or not, to be distinguished from the soft and unctuous soap-rock, or Smeclis?

The division of earths into *Vitrescentes* and *Apyri* is here omitted, since all of them are, in a due degree of heat, found equally apt, either *per se*, or by means of some natural or artificial mixture, to be reduced to glass equally as well as those hitherto called *Vitrescentes*; which are nearly the most refractory in the fire, and ought
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to be called *Vitrescentes cum alcali*, if their name was to have any connection with their effects.

Having now so far overcome the former ignorance, which was the foundation of the knowledge for distinguishing the mineral bodies into transparent or opaque, hard or soft, we prefer the decision of the fire, though we still labour under the misfortune of not being able to measure the degrees of fire with sufficient accuracy; for which reason we always must suppose a *plus ultra* in the experiments by fire.

Sand in reality is nothing else than very small stones; therefore, if a separate class were to be made of Sands, another class ought to be made, which should comprehend Gravel; a third, Loose Stones; and a fourth, Mountains. This would be a *multiplicatio entium præter necessitatem*; a fault which, under these circumstances, may easily be committed, though not so soon perceived.

The Saxa must for the same reason be excluded from any system: Otherwise it would be the same as if a botanist made a difference between the mistletoes, or such like vegetables, according to the different genera or species of trees, plants, walls, or rails, on which they grew.

Petrefactions, or *Mineralia larvata*, consist of such principles as ought to be described in their proper places, without regard to their figure; for which reason they cannot be enumerated a second time. The principal reason for collecting them is, to acquire a knowledge of such bodies of the animal and vegetable kingdoms,

doms, as are not usually found in their natural state; and in this respect they belong properly to the studies of the Botanists and Zoologists. For a Mineralist is satisfied with a single specimen of each different substance that has taken the shape of a vegetable or animal body, and this only to illustrate the history of their generation; he leaves it to others to decide if corals are vegetables, or the habitations of worms; and thus receives them very unconcernedly, after they have been mouldered to a chalk, changed into a spar, or into any other stony matter. Nevertheless, I have in the Appendix proposed a method for ranging the *Saxa* and *Petresfacta* in regard to the æconomical uses that may be expected from them.

Slate signifies or denotes the form alone, and not its kind or qualities; however, it regards only its situation in the rock, and not the texture of its particles; which latter I have always endeavoured to take notice of, since some difference in the effects frequently depends on it. And, as nothing is great or small but by comparison, it is difficult strictly to determine in what degree of thickness or thinness a stone begins to deserve the name of a slate. Nevertheless, I would have prevailed on myself to adopt this general name, if the breaking in thin plates had been the property only of any particular kind of stone, but it is by no means the case; because there is found in the province of Jemteland, in Sweden, a pure quartz, limestone, (both solid and scaly) indurated

rated boles, alum ores, and a great number of saxa, which are all of a plated structure, dividing into leaves as thin as pasteboard: And therefore I make no doubt but all kinds of stones may be found of such a figure in some parts of the world. What confusion would it not occasion if all these different kinds were included under one genus? And are there not solid stones found, consisting of the same constituent parts as the slates, which are separately considered in systems?

I could not range the ores according to the different kinds of rock in which they are found; for instance, the Goose-dung silver ore, the Liver ore, and many more of the same kind, since observations upon the matrices of ores belongs to another branch of the Mineral Science, called *Geographia subterranea*, or *Cosmographia specialis*; in which likewise the clefts, fissures, and veins or loads, that occur in every sort of rock, (in order to promote the circulation and fixation of the mineral vapours) are treated of. In that Science also the *Petræ Parasiticæ* are pointed out, whose number perhaps is not yet known; as likewise the glossy fissures from which the *Mineræ Speculares* have obtained their name. And this is a branch of science, which, in the hands of a skilful mineralist, is likely to furnish us with a perfect idea of the age of every sort of stone, and also of their different gradations between the two accidents to which all created beings are subject, Composition and Destruction.

Since it has not been usual to consider the earths and stones as the same, in regard to the principles of which they consist, and only different from one another by the greater or lesser hardness and coherency of their particles; I hope for excuse, in not being able to prosecute this Essay so far as to point out a particular earth for each kind of stone. Perhaps also some of the mineral bodies are already so much hardened, that no earths of this kind are to be found; or, perhaps, the little knowledge we have of them is owing to the neglect of not collecting earths with the same earnestness as we do stones and ores. If, therefore, all the earths which are ranged in certain modern systems, and there distinguished from one another, in regard to the difference of their colours and places where they are found, had fallen into the hands of Mr. Pott, and been tried by him in the fire, as he has tried the stones, and been described in his *Lithogeoognesia*, it is very probable that we now should know these bodies better, and their number would certainly be less perplexing.

The hints which are here given may, however, tend to promote the intended point for the future; and then perhaps the earths will be found not to be quite of so many different kinds as I have here been obliged to divide them into, for want of perfectly knowing their affinities and their several origins; because we have strong reasons to believe that the calcareous and argillaceous earths are the two principal ones, of which all the rest are compounded, although
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this cannot yet be perfectly proved to a demonstration.

The *Lusi Naturæ* are not separately treated herein; they may be found every where in the Essay, because the rock crystals do not appear to me less curious than the indurated marles; and the kidney ore is often found of a more surprising figure than the eagle-stone. I cannot therefore find any reason for forming a class of them, nor do I comprehend what others take to be a greater or less sport of nature in the mineral kingdom.

Figured stones, or which contain the representations of vegetables, animals, &c. occasioned by different veins or colours in the stones, are in my opinion of still less consequence, and are also more difficult to range properly in classes; because people seldom, or rather never, agree in their fancies; but what seems to represent an object to one, may make a different appearance in the imagination of another, whereby both confusion and disputes would arise about the bodies of such a class. Besides, a very small advantage, if any, can result from such a class; since all that the Almighty created has required equally his power, and is also equally worthy of our admiration: It gives rather rise to pedantry, whereby the attention is by degrees diverted from true knowledge to mere trifles, of which both ancient and modern books are sad instances; and if Mr. Du Fay had not impeded the evil by discovering the method of improving the figures upon flints
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and agats, we might still have seen whole collections full of them with such imaginary figures.

Stones that are found in animals and fishes, are partly compounded of phlogiston, salts, and a small quantity of earth, and partly consist of the same matter with animal bones, and can therefore with as little reason have a place in a mineral system as the stones of fruits. Soot, tartar, yeast, and things of such nature, have too great an affinity to the vegetable kingdom, and are never to be met with under the surface of the earth; wherefore they may in Botany be considered in the same manner as regulæ, glasses, and slags, are in Mineralogy.

The hair-balls found in animals, and felt, differ from one another in that the former are worked together by means of the peristaltic motion in the bowels of the animals, and the latter by the art of the feltmonger. May not all these stones of animals therefore be ranked among the *relicta animalia*?

By all this it is very evident, that my chief care has been to treat the mineral kingdom in such a manner, that those whose principal study it is, may avoid every thing unnecessary and superfluous; and by a perfect knowledge of the subjects be brought to consider how to employ them to the best advantage; whereby I hope that the pleasure of collecting minerals will rather encrease than be discouraged. If some objects are thrown out from mineral collections on account they do not belong to them,
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other collections will be augmented; and thus every thing will be brought into a due order. If some collectors should not immediately be able to comprehend this System or Classification, it cannot much detriment the science; and it is likewise of very little consequence in proportion to the advantage that will accrue to the study by this method, the more it shall be cultivated and improved.

Ptolomy cannot be supposed to have known the value of every book he sent to his great library in Alexandria, and he had doubtless no time to class them himself according to the contents of the different books acquired; however, his love for collecting must have continued during his life: Moreover, the advantages obtainable from it would have been afterwards discovered, had it not been dispersed; or, as sometimes happens, had not the collection been supposed to gain some additional value by being made difficult of access to the learned.

As soon as we are arrived to such a pitch, as by the examination of a mineral body to discover or know all its constituent parts, and can assert with certainty that it can be no further decomposed by any method hitherto known; then such a body ought, according to the intention of this Essay, to receive its specific name, and not before; for otherwise it will be vague and trivial. However, I have not assumed a confidence to do this even with such mineral bodies that I in some respect can aver I pretty well know, and which have not yet obtained

obtained any fixed name; as I think it proper to wait that event, until this Essay has passed through that trial which I sincerely wish it deserves to undergo, equally with others of the same nature. Then only will be the proper time to fix the genera and species, according to such characters as shall be found the most natural.

Meanwhile I flatter myself with so much success, that students, who intend to follow this proposed method, will not be so easily mistaken in the subjects of the mineral kingdom, as has happened with me and others in following former systems; and I also hope to obtain some protectors against those who are so possessed with the *figuromania*, and so addicted to the surface of things, that they are shocked at the boldness of calling a *Marble* a *Limestone*, and of placing the *Porphyry* among the *Saxa*.

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*The Sections marked A, are Additional and New:
and those E, were among the Notes to the first
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— 92	—	145	Note	—	201
— 93	—	153	—	{ viz. Sulphur.	—
— 94	—	154	125	{ See § 253.	—
— 95	—	63	126	—	177
— 96	—	64	127	—	159
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	<i>Author.</i>	<i>New Edit.</i>		<i>Author.</i>	<i>New Edit.</i>
Sect.	134. 177	281	—	175	277
—	135	168	—	176	278
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—	168	263	—	208	341
—	169	265	—	209	342
—	170	266	—	210	{ viz. the
—	171	268	—	—	{ <i>Tung Stein,</i>
—	172	270	—	—	{ or <i>Wolfram</i>
—	173	{ 271	—	211	{ 27
—	174	272	—	212	{ 402
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<i>Author.</i>	<i>N. Edit.</i>	<i>Author.</i>	<i>N. Edit.</i>
— 216	— 286	— 259	— 403
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C O R.

CORRECTIONS AND ADDITIONS.

Page.	Line.								
14	2	<i>expunge</i> [m].							
15	last	<i>fine</i> , <i>read</i> <i>fine</i> .							
17	18	<i>expunge</i> see Note (p.)							
21	23	<i>gur</i> , <i>read</i> <i>ghur</i> .							
<i>ibid.</i>	last	<i>add</i> see Sect. 130.							
28	14	<table> <tr> <td><i>Spatosi,</i></td><td rowspan="3">} read</td><td><i>Spatulæ.</i></td></tr> <tr> <td><i>Hexagoni,</i></td><td><i>Hexagonæ.</i></td></tr> <tr> <td><i>Truncati,</i></td><td><i>Truncatæ.</i></td></tr> </table>	<i>Spatosi,</i>	} read	<i>Spatulæ.</i>	<i>Hexagoni,</i>	<i>Hexagonæ.</i>	<i>Truncati,</i>	<i>Truncatæ.</i>
<i>Spatosi,</i>	} read	<i>Spatulæ.</i>							
<i>Hexagoni,</i>		<i>Hexagonæ.</i>							
<i>Truncati,</i>		<i>Truncatæ.</i>							
29	4 & 7	<table> <tr> <td><i>Distincti,</i></td><td rowspan="2">} read</td><td><i>Distinctæ.</i></td></tr> <tr> <td><i>Concreti,</i></td><td><i>Concretæ.</i></td></tr> </table>	<i>Distincti,</i>	} read	<i>Distinctæ.</i>	<i>Concreti,</i>	<i>Concretæ.</i>		
<i>Distincti,</i>	} read	<i>Distinctæ.</i>							
<i>Concreti,</i>		<i>Concretæ.</i>							
30	3	<i>Pisolithus</i> , <i>read</i> <i>Pisolithes</i> . <i>Oolithus</i> , <i>read</i> <i>Oolithes</i> .							
33	3	At the end of the Note (o), <i>add</i> Engeström.							
	8	<i>colour</i> , <i>read</i> <i>coloured glass</i> .							
35	16	Sect. 40, <i>read</i> Sect. 50.							
37	13	<i>gips</i> , <i>read</i> <i>gypsum</i> .							
42	14	<i>Add</i> , The fluor has this singular property, viz. that, on being melted by the flame of the blow- pipe, together with gypsum, the bead resulting from both is, all formed with facetes on the out-side. But if melted with barytes (ponderous earth), the bead has a surface quite round or spherical. <i>The Editor</i> .							
45	3	<i>of the Note</i> , <i>eválysis</i> , <i>read</i> <i>analysis</i> .							
49		<i>At the beginning of the Note</i> , <i>soals</i> , <i>read</i> <i>soils</i> .							
53	5	<i>Add</i> , Some are called <i>Ludus Helmentii</i> . See page 888. b. n.							
60	last	<i>Add</i> , See page 247, about the <i>Lapis Lazuli</i> .							

Page. *Lists.*

- 96 22 *Add, 16.* According to Lavoisier and Macquer, when Magnesia is calcined, it becomes phosphorescent.
- 124 29 of quartz; *read* of zeolytes.
- 125 12 *Add,* I have seen also a small cubic diamond belonging to Dr. Combe, of London, whose square sides were naturally joined by two very narrow long facets, forming angles of about 120 *degrees*; and its corners were quite perfect. *The Editor.*
- 131 11 *Add,* If the model be exactly done.
- 133 *Add at the end,* Adamantine spars, so called on account of their extreme hardness, have been brought within these few years from the East-Indies. They are known by the name of *grinding spars* at Madras, as their powder is probably employed there to polish hard gems. Their figure is that of a right hexagonal prism, of a grey greenish colour, partly covered with a dark bluish crust, to which was adhering part of a calcareous matrix. The substance of these spars is lamellated and semi-transparent, discovering blackish spots within, some of which are also at the surface, and are magnetic; these produce sparks when electrified. Some of the spars appear partly micaceous. I have seen one of them about *two inches* long. Another, about half this size in its diagonal length, being weighed hydrostatically by Mr. Kirwan's operator, gave 3,847 for its *specific gravity*, weighing 376 grains in the air, and losing 9,775 in distilled water. According to Mr. Haüy, these spars constitute a new kind of crystalline bodies; but I do not know whether they have been as yet properly analysed.

Page. Line.

lysed. See Journ. de Physiq. for May 1787, p. 195.

P. S. The white earth adhering to the Adamantine spars, being dissolved in dilute *nitrous acid*, formed a *white* precipitation by *volatile alkali*.

This precipitate by the *Prussian alkali* was *blue*.

By the *acid of sugar*, it gave none.

And, by the *vitriolic acid*, it formed an *alum*.

So that this *white crust of the Adamantine spars* consists of *calcareous earth*, with some *Argil* and *iron*; besides the *mica*, which is very visible. *The Editor*.

- 160 27 ferment, *read* effervesce.
- 181 20 Add, and dried afterwards.
- 182 Add at the bottom, This is the Enhydros of Pliny. B. 37. c 11.
- 193 9 Pavoniua, *read* Pavonina.
- 28 Metites, *read* Melites.
- 198 At the end of Note h, add Fabroni.
- 202 8 (69) *read* (68).
- 207 12 expunge 92(.
- 214 17 of the Author, *read* of the Swedes, described in Sect. 137.
- 223 13 Add, Mr. de Morveau asserts, however, that he has also produced a very small artificial crystal; and gives the proper method to succeed in the process. See Vol. I. of the Dijon Memoirs for 1785.
- 299 24 13:8 *read* 11:8.
- 301 5 Add, See Note c to Sect. 163, page 307.
- 304 17 Sect. 27. *read* Sect. 28.
- 311 15 Of animals, *add*, was published.
- 314 3 of the Note, gave him, *read*, told me to have given him.

Page. Line.

316 18 *of the Note*, precipitated, *read* separated.

320 16 *of the Note*, salts, *read* tests.

324 10 *of the Note*, the second, *read* the third.

384 15 195, *read* 196, (Additional).

445 *Add to the end of Note c*, But the late experiments communicated by Dr. Priestley to the Royal Society of London, which will be inserted in the Philosophical Transactions for 1788, demonstrate, that the above opinion of Dr. De la Metherie is the true one; viz. 1. that the water or moisture remaining after the repeated explosions of *inflammable* and *dephlogistated air*, was previously contained in them both. 2. That if they are previously taken upon mercury, covered with *fixed ammoniac*, and well shaken with it, they then hardly produce the half, or less, of that watery moisture. 3. That all aeriform substances, as the *phlogistated*, *dephlogistated* and the *inflammable air*, cannot be produced without water. 4. That the inflammable air, produced by the vapour of boiling water passing through a red-hot iron tube, proceeds from the metal, to which the water unites and calcines it; whilst the *inflammable part* (or the *phlogiston*) of it, is expelled with part of the same water, in the form of what is called *inflammable air*.

Finally, the experiments and ingenious deductions of Dr. Crawford, in the second edition of his Treatise on Heat and Combustion, (just now published, the 13th of April, 1788,) irresistibly evinces the fallacy of the pretended arguments against the existence of *phlogiston*.
The Editor.

495 8 *of the Note*, 12, *read* 12 ounces.

Page. Line.

545 7 of the Note, 1754 to 1736, read 1754 to 1756.

557 10 Add (a).

565 14 *erez*, read *eriz*.

576 35 William, read Thomas Cooper.

578 15 of the Note, No. 5, read No. 6, of the Note to page 614.

662 6 from the bottom, add, and Note b, to page 544.

747 Add to Note 11, The strong blast of air, whilst the cast iron is red hot, or rather in a half melted state, is the most necessary, if not the only necessary circumstance, to render it malleable. In this operation a quantity of liquid matter runs from it, called *finery cinder*, which is very brittle when cold; and on its being separated from the metal, the latter remains malleable. But the iron being in loose spungy masses, requires the hammer to consolidate it, and a considerable quantity of the *finery cinder*, which remains among the interstices of the spungy fibres, is driven out by the application of the hammer. The *finery cinder* is thrown away, as useless, by many iron-masters; but it has been found, that it may be partly employed, with the other usual fluxes, to smelt the iron-ores. The Editor from *Priefily*. Observ. on Nat. Ph. Vol. III. p. 357. and 372.

756 14 Add, See however, Note 14, page 840, concerning the magnetic power of Nickel.

757 to 801, At the top of every page, instead of *Base Metals*, read *Semi-metals*.

787 30 by whom, read, by which.

793 2 Sect. 307, read 767.

Page. Line.

795 19 (243), read (234).

893 6 *Add*, A singular variety of sand-stone, which is flexible and *elastic*, was shown to the Royal Academy of Sciences at Paris, four years ago, by the Baron de Dietrich. It consists of small grains of hard quartz, that strike fire with tempered steel, together with some micaceous mixture. The elasticity seems to depend on the micaceous part, and softness of the natural gluten between both. It is said, that this *elastic stone* was found in Brazil, and brought to Germany by his Excellency the Marquis do Lavradio.

There are also two tables of white marble, kept in the Palace Borgheze, at Rome, which have the same property. But the sparry particles of their substance, though transparent, are rather soft; may be easily separated with the nail, and effervesce with *aqua fortis*: and there is also in it a little mixture of small particles of talc, or mica. See Journal de Phys. for October, 1784, p. 275.

910 *Add to the middle of this Page*, The great volcanic eruption in Iceland above-mentioned happened in June 1783, after having been preceded for 10 days by violent earthquakes, thick clouds of smoke, and dense streams arising out of the earth. It did burst at last, and continued during the three following months. Three spouts of fire broke out from different mouths, which, after rising to a considerable height, collected into a single stream, so high as to be seen at the distance of 34 miles and upwards, throwing out with great force, noise, and shaking of the earth, prodigious quantities of brimstones, sand, pumice-stones, and ashes, which
fell

Page. Line.

fell all over the country at great distances, along with great quantity of a dirty substance, resembling pitch. The melted lava ran out in such abundance, as to cover the land above 15 miles in length, and seven in breadth, and formed lakes of ignited matter, which filled and dried the beds of 12 rivers; entirely destroyed 20 and more villages, besides 30 more which were materially damaged. Two new islands were thrown up afterwards from the bottom of the sea, one above 100 fathoms from the bottom, and the other farther off between Iceland and Greenland; both were burning without intermission for a long time, and produced the most dreadful effects, &c. *See the account of this horrible convulsion of that almost neighbouring part of our globe, in the Magazine of Edinburgh for June, 1787.* If ever the land or ground of England was separated, as it seems, from that of France, at an epocha preceding all written records, there is no doubt but that there must have happened a convulsion on this part of the globe, similar at least, if not greater, than that at Iceland. *The Editor.*

914 3 *before the end, the calcareous spar, read, the polygonous configuration.*

ESSAY

E S S A Y
TOWARDS A
S Y S T E M
OF THE
MINERAL KINGDOM.

SECTION I.

On the formation of Minerals.

THE Mineral Kingdom contains all those bodies which have been formed under the surface of our earth, whether at the first creation, or at any other time since that period; and which are still daily produced from their original or primary principles; being destitute of seed, life, or any circulation of fluids [a].

The

[a] The limits between the three acknowledged kingdoms of Nature are almost impossible to be ascertained; whence arises the difficulty of giving any true definition of them: and indeed it may be questioned, whether such general definition would be of any use, when we become so far advanced in knowledge, as to be able to distinguish, on sure foundations,

The words, *circulation of fluids*, are to be considered jointly with what is before supposed, viz. that the mineral bodies are formed *under the surface of our earth*: and, by this particular, they are distinguished from the subjects of the vegetable kingdom; with which, in other respects, they have some resemblance, some fossils being still produced nearly in the same manner as we conceive vegetables to be. The clefts, fissures, and veins [b], in the rocks, and in the strata of the earth, may be looked upon as answering to the tubes in vegetables, and the water as the vehicle of nutriment common to them both. Fire, of whose nature we still know so little that we can hardly determine whether it exists in the earth in any peculiar manner or quantity, farther than it must necessarily exist in the general or solar system, may, perhaps, be an auxiliary equally necessary to all the three kingdoms of nature.

the several individuals belonging to each kingdom: and likewise those which form the connexion between the three.

However, at present, it is necessary that the several parts of Natural History should be treated of separately; and as the whole extent of this knowledge can hardly be expected from one man, it may perhaps be executed to more advantage by different persons: in the mean time, we must be content with definitions, if they give tolerable ideas of the substances described, though they should not perfectly coincide with the strict rules of logicians. This being premised, I shall endeavour, in the text, to give some explanation of my own definition. *The Author.*

[b] Or *countries*, which is an English mine-term for the sides or inclosures of a vein or load of ore: e. g. the *country* of the lead is limestone, killas, &c. &c. D. C.

On the other hand, we know, with a kind of certainty, that if the mineral kingdom is allowed to have existed before the other two, and to have furnished them with materials for their existence, it is at the same time deprived of those wonderful and incomprehensible qualities of life and production of seeds, the properties of the animal and vegetable kingdoms.

Minerals are here to be described in the state and condition in which they are now actually found: nor are we to enter into the principia, or primary atoms, which have concurred to their formation, and into which we cannot now resolve them; since it may be presumed that the Creator made only one kind of matter, from which every thing we meet with in this world has been produced.

Minerals have been defined as bodies that grow by the external apposition of particles: but this definition, on reflection, will hardly be found sufficient and adequate; because the circles produced by the annual stagnation of the sap in the wood of a tree, and the coats or crusts of a stalactites, are effects nearly resembling one another. If it should be said that the particles on which the yearly growth of a tree depends, are not carried by the water, and merely deposited between the bark and the parts of the preceding year now become solid, but that they are juices secreted from the interior parts through the pores of the tree; I could likewise show instances in the mineral kingdom, that seem plainly to indicate some process similar to the formation

of the callus in a fractured bone; although this happens only at a certain age of the rock: and who knows whether this observation or process does not hold good also in the animal and vegetable kingdoms? But this still remains too great a problem with regard to the mineral kingdom: and we cannot for this reason admit any *circulation of juices*; not to mention that we have another refuge left, namely *shrinking* or *contraction*, and *expression* or *squeezing*, of which more will be said hereafter. We take more notice perhaps of what happens in the animal and vegetable kingdoms, because we are ourselves subject to the same alterations, and likewise outlive the greatest part of them, so that we can treat them with more ease and convenience; whereas the changes which the mineral kingdom undergoes are hidden to us, and require many centuries to compleat them.

I cannot suppose mineral bodies to be produced by seeds, for want of proof; and I do not know why the metals should have any preference in that respect. Native or virgin copper and silver are produced in the same manner as the stalactites. The water carries along with it the invisible particles of lime, copper, or silver, and deposits them upon other subjects, either by means of an attractive power in these, or by some alteration in itself, occasioned by its motion. The precipitated particles are, at the beginning, very easily separated; but in process of time they cohere very firmly, as is evidently seen in the native precipitated or
Ziment-

Ziment copper [c], which, after it has been some time taken out of the water, is partly malleable. The figure which native gold and silver have in their rocks or beds, does not prove any thing more, than the accretion of iron or copper in a metallic state into a moss-like form in the poor or rich roasted ores or reguli, does at the furnaces; it gives us rather an idea, how those accidents happen, merely by the shrinking and the sudden cooling of their surfaces: and we can then also begin to conceive something of the reason why crystals are found in a pebble form, or in loose nodules, as the *petrified melons of mount Carmel*, and the Italian iron ores, in form of balls, &c. without being under the necessity of recurring to the supposition of a melting heat; if we only carefully observe those marks, which, besides, plainly shew their having once been soft, or dissolved.

Many observations and experiments must yet be made before we can determine whether mineral bodies are at present formed, in that large elaboratory the earth, by the very same process as the situation and circumstances of full-grown minerals seem to have required.

The whole flinty clais may be offered to evince the truth of this assertion. We have not one observation that determines the manner of their generation. For if any one should pretend to have discovered the quartz cry-

[c] Called *Ziment-copper* from its being first observed in a vitriolic water, called *ziment*, at Herrengrund, in Hungary, D. C.

stals [d] in the very instant of their shooting, it might be asked, Whether he only depended upon the figure, or if he had made experiments sufficient to convince us, that no calcareous earth, either pure or disguised, was also at the same time mixed therewith? To enumerate the many different ways of generation, which we have any reason to suspect, does not properly belong to this work; besides, it would carry me too far from my subject, and might also surpass my capacity to explain. I will, however, by mentioning the following opinions, try to animate persons of more experience and leisure to the pursuit of these enquiries.

Precipitation from or by means of water, is already mentioned; as well as a hint given about the formation of flints. This last does not suppose such a softness as that of clay when mollified with water; but a slimy gelatinous, or mucilaginous matter; and consequently, a more radical solution, if I may be allowed that expression; and this is again to be considered as a different method.

Another manner of accounting for this formation of mineral bodies, more generally received at present, is that by decomposition [e],
partly

[d] The author uses the term *quartz crystals* for the true crystals; for all foreign authors call the *figured spars* also crystals; and distinguish them by the name of *spath* or *spars-crystals*. D. C.

[e] By *destruction that acts privative* (as it is in the original) is to be understood, that some few ores, owing their origin to decomposition, are formed out of others, which, by
some

partly by very violent means, such as subterranean fires, and partly by more mild ones, such as the weathering, wasting, or decomposing away; and by this way we have innumerable varieties, and new compositions. The vitriolic and muriatic *acids* do not lie dormant; and being once let loose by the said way of weathering or destruction, they do not stop till they are saturated with something. Where these acids cannot penetrate by themselves, they are forwarded by the water, which, according to the laws of nature, is almost continually in motion: but the effects of these salts ought again carefully to be distinguished from those of the water alone, because this latter acts both as a menstruum, for instance, upon the calcareous earth; and at the same time by its *vis inertiae*, heaviness and motion, wears off or abrades some particles from solid bodies: carries them along: and deposits them in other places, where these particles often acquire a different position from that they had before. Are the *Bog-ores* produced of decayed mundics, although no vitriolic matter is found in the waters or tracts around them? or, are they to be reckoned a sediment of martial earth dissolved in water alone? Would it be amiss to suppose, that a vegetable mould may of itself be

some natural operation, have lost one or more of their constituent parts. So *brown-iron ochre* is produced by *decayed pyrites*: *black-copper*, and that ore called by the Germans *Fablerz*, from decayed copper-pyrites, &c. *Note of the Editor from the German translation of Prof. Werner.*

changed into iron; since it is found to yield from a grain to about half of its weight of the said metal; as the experiments demonstrate, made upon the turf-moors which are at the foot of the hills or high rocks in the provinces of Dalarne, Jemtland, and Herjeadalen, in Sweden? or, that certain vapours have predominated, and still shew their power within certain districts, where they attack, and fix themselves to such matters as are most analogous to them; so that trees, which have been buried in the earth, in some of its subversions, have met with martial vapours in some parts of Bohemia; the flint-producing principle of Loughneagh in Ireland, and at Adrianople; with the inflammable substance in the strata of the coal-pits in England, and at Boserup in the province of Skone in Sweden? or, that shells must, without the destruction of their calcareous principles, be changed into a calcareous spar, as at the Balsberg in Skone; be filled with flint, as at Vernon in France, and in Siberia; or be penetrated with marcasite, as at Andrarum in Skone; or with a green copper ore, as at Jarlsberg in Norway? Silver seems to predominate at Kongsberg in Norway, as the copper does in the north part of that kingdom: and the same kind of stone in which gold abounds at one place of the world, may contain none at all at another place; and other such examples occur.

I now leave this important subject, that I may not discover my farther want of knowledge therein; but I take the liberty, at the same time, to give this advice to beginners,

viz.

viz. not to conclude, that one mineral body is produced by another, only because they are situated near one another, if it cannot at the same time be demonstrated by the analysis, or by artificial mutation : nor to content himself with making his observations only on collections of minerals, or on heaps of ores, but to prosecute them to the very workshop of nature herself, where they may be made with more certainty, though in a narrow compass ; I mean, in the very mines, quarries, and diggings, of the strata of the earth. For I myself have been astonished to hear that the flint is said to be produced by a calcareous substance, only because it is found in the strata of chalk in England, and in the limestone at Kinnekulle in the province of Westergottland in Sweden : and I am farther of opinion, that a stone separated from its bed, and thrown loose on the surface of the earth, does not discover more marks of increase, than bones do when dispersed in a church-yard.

S E C T. 2.

General division of Minerals, or Fossils.

The bodies belonging to the mineral kingdom are divided into four different classes : *viz.*

1. EARTHS, are those substances which are not ductile, that are mostly indissoluble in water or oil, and that preserve their constitution in a strong heat [*f*].

2. SALTS,

[*f*] Earths are insipid, not soluble in 1000 times their weight of boiling water, though perhaps water, in Papin's digester,

2. SALTS, are soluble in water, and give it a taste; and, when the quantity of water required to keep them in dissolution is evaporated, they concrete again into solid and angular bodies [g].
3. INFLAMMABLES, are soluble in oils, but not in water, and are combustible [b].

digestor, will dissolve some, if not all, of them; especially if their surface be greatly increased by a previous solution in, and precipitation from, some other menstruum. In the chain of nature, they are by insensible gradation, joined to the salts, so as not to be distinguished without artificial limits. Their form is not changed by a moderate heat, nor are they dissipated by a violent one. Their specific gravity is, to water, less than 5 to 1. Bergman's *Sciagraphia*, § 21.

Wallerius and others, out of a too scrupulous attention to the *externa facies*, make stones one of the genera of fossils, the consequence of which is, as Bergman justly observes (*Sciag.* § 7.) "that a stone of a certain size must constitute one genus, whilst the same, reduced to powder, must be placed under another genus, which shall not be found even in the same class."

[g] Salts, or saline substances, are more or less sapid, and when finely powdered dissolve in at least 1000 times their weight of boiling water. They melt in the fire, which for the most part changes or destroys them. *Berg. Sc.* § 20.

The definition of salts by Dr. Cullen seems less exceptionable; viz. *Saline bodies are sapid, miscible with water, and not inflammable*. However the *volatile alkaly*, in an aerial state, is in a certain degree inflammable. *Dr. Withering.*

N. B. The study of Mineralogy, according to the great Bergman (*sc.* § 24.) should begin by acquiring a good knowledge of the nature and properties of saline bodies; for, unacquainted with these, says he, our knowledge of other bodies must be exceedingly imperfect. *The Ed.*

[b] Inflammable fossils abound with phlogiston, do not unite with water, but when pure dissolve in oils: exposed to the fire, they smoke, generally inflame, are for the most part consumed, and sometimes totally vanish. *Berg. Sc.* § 22.

4. METALS

4. METALS, are the heaviest of all bodies hitherto known [*i*], some are malleable, and some can be decomposed; nevertheless, in a melting heat they can again be recovered, or brought to their former state, by adding to them the phlogiston they lost during their decomposition [*k*].

SECT.

[*i*] Metals when perfect do not dissolve at all in water; only a few of them in oils, and then only when in part deprived of their phlogiston. They are the heaviest of all known substances, the lightest of them weighing more than six times its bulk of water. They melt in the fire, with a shining surface: and, in clay vessels, the surface is convex. Berg. sc. § 23.

[*k*] Here occurs the same difficulty in regard to the definitions, as was before (Sect. 1.) observed, because these enumerated classes are likewise blended one with another; and therefore some exceptions must be allowed in every one of them: for instance, in the first Class, the calcareous earth is in some measure dissoluble in water, and pipe clay, with some others, diminish somewhat in their bulk, when kept for a long time in a calcining heat. In the third Class, the calx of arsenic has nearly the same properties as salts; and there is no possible definition of salt, that can exclude the arsenic, though, at the same time, it is impossible to arrange it elsewhere than among the semi-metals. In the fourth Class it is to be observed, that the metals and semi-metals, perfect or imperfect, have not the same qualities common to them all; because some of them may be calcined, or deprived of their phlogiston, in the same degree of fire, in which others are not in the least changed, unless particular artifices or processes are made use of: some of them also may be made malleable, when others are by no means to be rendered so. That convex surface metals take after being melted, is a quality not particularly belonging to them, because every thing that is perfectly fluid in the fire, and has no attraction to the vessel in which it is kept, or to any added matter, takes the same figure; as we find the borax, *sal fusibile microcosmicum*, and others

S E C T. 3.

The first class Earths. Lat. Terræ. Sw. Jordarter. French, Les Terres. Germ. Erdarten.

EARTHS, are those mineral bodies which are not ductile ; for the most part not dissoluble in water or oils ; and that preserve their constitution in a strong heat [1].

others do, when melted upon a piece of charcoal : therefore, with regard to all that has been said, it is hardly worth while to invent such definitions as shall include several species at once ; we ought rather to be content with perfectly knowing them separately. However, as this is to be an Essay towards forming a System ; I have endeavoured, in most parts, to follow the usual rules. *The Author.*

[1] *in a strong heat* without melting, like *metals* ; though earths may sometimes vitrify, and become glass, by strong heat ; nor flying or vanishing away, like *bituminous* substances : that, notwithstanding they be reduced to the finest powder, yet are not soluble, like *salts*, in open vessels, though in a quantity of boiling water 1000 times their weight ; nor have, like them, any taste when applied to the tongue ; and, finally, they are specifically lighter than five times their weight of water, as above said in note *f* to § 2.

Earths however are, in many instances, so far of a saline nature, as to be soluble by means of Papin's digester. This holds good even in regard to *Quartz*. Indeed in the state in which earths are found in the ground, they are almost always combined with an acid, and are therefore in fact, according to their different natures, so many *earthy salts*. These are also called *middle salts* (*sales medii terrestres*), being combined with soluble salts ; but of these hereafter, in the second class of this Essay. *Ed. from Berg.*

These

These Earths (§ 3.) are here arranged according to their constituent parts [*m*], as far as hitherto

[*m*] The Author means to treat of earths under so many heads, as there are primitive or simple earths; viz. such as cannot be decomposed, nor changed into one another; or undergo any real transmutation, by any means whatsoever as yet known. Modern discoveries have however reduced their number to near the half there reckoned by the noble author. It appears, by the numerous and most accurate analyses of mineral bodies, made by that great philosopher Sir Torbern Bergman, Professor at Upsal, that there are only *five*, or at most *six*, primitive or simple kinds of earth. The following are his words, in a letter to Dr. Troil, written in 1776, and printed in 1780, among those of this last, on the subject of Iceland: "I have," says that eminent chymist, "for several years past, endeavoured to discover the number, as well as the nature, of the original kinds of earth. In the year 1758 Mr. Cronstedt counted nine: if he had lived longer, for the benefit of the sciences, he would no doubt have rectified this account." The following are the same Professor's words, in his *Sciagraphia*, lately published (in 1782) § 83, and following. "Before we can understand the nature of earths, we must know their component parts. Those earths, which cannot be further decomposed, we call *primitive*; and those which consist of two, or more, of these intimately united, *derivative*. By this union we do not mean a mere mechanical diffusion, at least not such as can be distinguished by the eye, as is the case in stones (*saxa*.)

"It is evident that the primitive earths will constitute so many natural Genera, and different mixtures of these the Species.

"They who would make several Genera out of one primitive earth, must separate the glassy, red, white, horny silver ores, and other different compositions, into as many Genera, or else act inconsistently with their own principles.

"At present we only know five primitive earths. They who reckon fewer, rest their opinions upon fanciful metamorphoses unsupported by faithful experiments. As experiments teach us that there are five primitive earths, it is
evident

hitherto discovered; and are divided into nine orders [m].

SECT.

"evident that the species arising from the mixture of these
 "cannot exceed twenty-four, viz. 10 double (consisting of
 "two earths) 6 triple, 3 quadruple, and the 5 primitive.

"Although these different mixtures are possible, and probably do exist, they have not yet been all found. The
 "natural compositions of acids with the earths, forming substances not soluble in 1000 times their weight of boiling
 "water, and which may be called saline earths, must be added
 "to the species, as they are certainly chemical combinations.

"The primitive earths hitherto detected are,

"TERRA PONDEROSA, or heavy earth.

"CALX, - - - - - calcareous earth.

"MAGNESIA, - - - - - magnesia.

"ARGILLA, - - - - - argillaceous earth.

"TERRA SILICEA, - - - - - siliceous earth.

"And we must believe these to be primitive, until it shall
 "appear, by proper experiments, that they may be separated
 "into others still more simple, or changed into one another
 "by art.

"These are first to be considered in their greatest simplicity
 "and purity, although nature never presents us with such,
 "nor can they even by art be rendered absolutely free from
 "all heterogeneous mixture. Water and aerial acid readily
 "unite with the four first, and when expelled by fire, a little
 "of the matter of heat is added, and remains until driven
 "out by a more powerful attraction. But in this state they
 "possess a degree of purity not to be attained by any other
 "known method. Therefore it is necessary to examine them
 "when sufficiently burnt, in order to distinguish better what
 "properties depend upon adhering heterogeneous matters."

To the above five kinds of Earth, Professor Bergman added, at first the *Earth of Gems*, as being of a different kind: but he found afterwards, that all gems, the diamonds excepted, are compounded from some of the above earths, and
 may

S E C T. 4.

General Properties of Calcareous Earth.

C L A S S I.

F I R S T O R D E R.

Calcareous Earth, Chalk. *Lat.* Terra Calcare.

Sw. Kalk-Jord, Brann-Jord, Krita.

French, Terre Calcaire. Craie.

Germ. Kalckartrige erden, Keide.

Specimens of this earth, when pure and free from heterogeneous matters [*n*], have the following qualities common to them all [*o*]:

i. That

may be said to belong to the *Argillaceous* kind, because this is the most predominant of their component parts. Nevertheless the generality of mankind have from immemorial time been apt to consider precious stones, as of a distinct and superior rank, among mineral productions, on account of their brilliancy, fine colours, and great hardness: and on this account they deserve to be separately treated of in a system of Mineralogy. As to the earth of diamonds, although its characteristical properties are as yet unknown; it is however well ascertained, that it does not belong to any of the five kinds of earths already mentioned. See *Bergm. Opusc. De terra gemmarum. tom. 2. pag. 72, & foll.* The Ed.

[*n*] As calcareous earth united to the *aerial acid* is found native, it requires but little trouble to have it pure. Let selected pieces of chalk, reduced to fine powder, be repeatedly

1. That they become friable, when burnt in the fire; and afterwards fall into a white powder [*p*].

2. That their falling into powder, is promoted if, after being burnt, they are thrown into water, whereby a strong heat arises, and a partial solution.

peatedly boiled in pure water: this dissolves any *calx*, or *magnesia salita*, which it may contain. This done, it holds no heterogeneous matter, but what mechanically adheres to it, the quantity of which is generally extremely small. If we desire to be free from this likewise, dissolve the washed chalk in distilled vinegar; precipitate with volatile alkaly; and after washing the precipitate well, dry it. *Berg. Sc.*

[*o*] The specific gravity of calcareous earth thus purified, is 2,720. 100 parts of it contain about $\frac{34}{100}$ of aerial acid, $\frac{11}{100}$ of water, and $\frac{55}{100}$ of pure earth.

Acids unite with it effervescing, and a centenary (*centenarius*) excites about 22 degrees of heat. The vitriolic acid forms *gypsum*, difficult to dissolve, (59). The *nitrous* and *muriatic acids* form deliquescent salts (§§ 60, 61), and the *acetic acid* permanent crystals. *Berg. Sc.* § 93.

[*p*] Pure calcareous earth does not melt in the fire, but loses $\frac{1}{100}$ of its weight. It dissolves in 700 times its weight of water, generating heat. Acids dissolve it, producing, from a centenary, 252 degrees of heat, but without any effervescence. This last circumstance may be best observed by immersing the burnt earth in water, to dissipate a part of the heat, which would otherwise make the acid boil. The water likewise expels the atmospheric air from the pores of the lime. In this situation, if nitrous or muriatic acid be poured upon it, and if it was previously well burnt, no effervescence will take place. The solution proceeds slowly, but the saturation becomes as perfect as if the calcareous earth had been in a mild state. This burnt earth, or *lime*, expels the *volatile alkaly* from *sal ammoniac* in a caustic state, and it dissolves *sulphur*; but this compound is separated upon the addition of any acid, even the *aerial*. *Berg. Sc.* § 93.

3. They

3. They cannot be melted by themselves, or *per se*, into glass in a close fire.

4. When burnt, they augment the causticity of potashes.

5. They are dissolved in acids with effervescence [q], in the following manner.

a. The *acid of vitriol* unites with them, and partly forms a precipitate, which is a *gypseous earth*, and partly shoots into *selenitical* crystals after a due evaporation of the *menstruum*.

b. With the *acid of common salt*, they make a *sal ammoniacum fixum*, which also partly precipitates [r].

c. The *acid of nitre* dissolves them perfectly; and does not part with them again [s], unless some *alkaline salt* is added. See *note (p)*.

6. They

[q] As calcareous earth contains near $\frac{2}{3}$ of *aerial acid*, it effervesces only with any other acid that is stronger than *fixed air*, because it then parts with this last: but if it has no *aerial acid*, then it does not effervesce at all. *Ed.*

[r] Calcareous earth combined with the *acid of ammoniacal salt* (viz. the *marine*, or *muratic acid*) produces the *Homburg's phosphorus*. See *Macquer's Dict.*

[s] Calcareous earth combined with *nitrous acid*, forms a *deliquescent salt*, which combination evaporated to dryness, and then made to undergo a certain degree of calcination till it becomes yellow, emits light in the dark for above $\frac{1}{4}$ of an hour, after it has been exposed to the sun-shine, or even to a candle. This is known by the name of *Baldwin's Phosphorus*, from it's inventor. *Berg. Macquer.*

[p] Calcareous earth combined with *fluor-acid*, forms the *sparry fluor* of sect. 22. *Fabroni.*

6. They melt easily with borax into a glass, which suffers inpressions in a degree of heat below ignition.

7. They likewise fuse into a glass, with *sal fusibile microcosmicum* with an efferverence [t].

8. Flus-spat melts the most readily of all kinds of stones, with the calcareous, into a corrosive glass or slag [u].

9. They have also some power of reducing certain metallic earths or calces; for instance those of lead [w] and of bismuth: and likewise,

With *phosphoric acid*, it forms the earth of *animal bones, nails, hairs, horns, &c.* This was discovered in Sweden by J. G. Ghan, but a few years ago. *Fabr.*

With the acid of vinegar it crystalises into a neutral salt, which does not deliquesce like those produced by the *muratic* and *nitrous* acids. *Berg.*

[t] It is to be understood that this effervescence is also made with *borax*, as well as with this *sal fusibile microcosmicum*; and it is also to be observed that the glasses made with these salts, are quite colourless and transparent. *The Author.*

N. B. These glass-beads are transparent only whilst they are hot; but as soon as they cool, they become opaque. There is however a remarkable phenomenon to be noticed; viz. that if the hot bead is thrown into melted tallow, or even into warm water or any other warm liquor, it preserves its transparency. *The Editor* from Bergman, *de tubo ferruminatorio.*

[u] *Corrosive*, because certain vitrifications of calcareous earth, particularly those made with calx of lead and sparry fluor, eat through the crucibles. *Werner.* N. B. This must be totally attributed to the solvents: Glass of lead being the most active of all fluxes, and the sparry-acid, which is one of the constituent parts of the sparry fluor, is already known to corrode even glass vessels. *The Edit.*

[w] This is to be understood, when calcareous earth is combined with *aerial-acid*: thus calces of lead are in some measure

wife, though in a less degree, those of copper and of iron: thus

10. They do in this last mentioned case (article 9), as well as in other circumstances, resemble *fixed alkaline salts*, from whence also this whole kind is very often, and properly, called *alkaline earths*.

11. This earth is common to all the three kingdoms of nature. For it is found in the bones and shells of animals [x], as well as in the ashes of burnt vegetables; it must, consequently, have existed before any living or vegetable substance; and is, no doubt, distributed throughout the globe, in a quantity adequate to its universal use.

measure reduced by chalk, but not at all by lime; and this evidently proves, that they receive phlogiston from *fixed air* or *aerial acid*, which is a compound of *phlogiston* and *dephlogisticated air*. Kirwan.

[x] Mr. de Morveau has evidently proved this *earth* to be *calcareous*, and that the *absorbent* earth supposed by Messrs. Sage, Romé de l'Isle, &c. is nothing more than a mere *calcareous earth*. See his *Memoir inserted in Journ. de Physique* for March 1781. The Edit.

S E C T. 5.

The calcareous earth is found.

I. Pure [u].

1. Loose, in form of powder, *agaricus mineralis*, or *lac lunæ* [w].

a. White, is found in moors and at the bottom of lakes, at Reden in the province of Jemtland, at Timmerdala in Westergottland: and also in the provinces of Smöland, Östergötland, and island of Gotland in Sweden [x].

[u] It appears from what has been said in the preceding section, that as far as we know, pure calcareous earth is not found native. The specimens of this division consist chiefly of the *calx aerata* or calcareous earth combined with the aerial acid or fixed air. But the following species, mentioned by Wallerius, may as well be noted here.

1. *Calx nativa Wallerii*, vel *terra aceldama*.

This calcareous earth hardens immediately with water, as quick lime does.

Calx Balnei Bathensis. It is found at Bath in England: effervesces with cold water: and when mixed with brimstone, forms a *liver of sulphur*.

Calx nativa Panormitana. It is found near Palermo in Sicily, and is called *washer's earth*; when mixed with water it does not effervesce, but consolidates into a hard mass." Wall. No. 4. page 31 & seq. vol. I. 1778.

[w] This is a mistaken name, taken from the Swiss word *Month*, which signifies *mountain*, confounded with the German word *mond*, which signifies *moon*. The German name of this earth is *bergmilch*, mountain milk. Wern.

[x] The white *mineral agaric*, so called from its fineness and lightness, resembling the vegetable agaric, is found in swamp or peat moors, in England and Scotland; as likewise in the fissures of the free-stone quarries of Oxfordshire, Northamptonshire, &c. but the red and yellow sorts I never heard of in England. D. C.

b. Red

b. Red is also found in Gottland.

c. Yellow, is found at Timmerdala, in Westergottland [*y*].

S E C T. 6.

II. Friable and coherent, *Solida Friabilis*, Chalk, *Creta*.

a. White *Creta alba*, is found in England, and France, and in the province of Skone in Sweden, in which last place it is only found adherent to flint: in the two first kingdoms there are large strata of this substance, in which flint is imbedded. This seems to indicate, that the loose flints, or those dispersed on the surface of the earth,

[*y*] This kind of earth seems to be an impalpable powder of mouldered limestones abraded and collected by the waters, and is therefore common in the neighbourhoods where limestones are found; and if the stone is at some distance, which is sometimes the case, still nothing contradictory appears in this opinion of the origin of this species; since in that case it has only been carried farther by the greater rapidity of a stronger current of water. When this earth is found in the clefts of rocks, it receives more pompous names, such as *Gur*, *Lac Luna*, &c. &c. It is conveniently burnt into lime, if it is previously pressed into moulds, that it may better cohere: it is in its native state, used for white-washing; but easily rubs off by the least touch. At certain places in the province of Smoland in Sweden, there is found in the moors a white earth, which, by its external appearance, resembles the species here described; but it does not shew any marks of effervescence with acids, nor does it burn into lime. It were to be wished that those who have an opportunity of getting any quantity of this latter earth, would undertake to examine it better.

Auth.

have been by some causes carried from their native beds; but, as yet, no one can prove, that chalk and flint are of the same constituent parts.

Chalk is, however, a vague name, and applied to other earths; whence we hear of chalks of various colours: but I do not know of any which are of a calcareous nature, except the kind here described, and of which there are no other varieties, otherwise than in regard to the looseness of the texture, or the fineness of the particles.

S E C T. 7.

III. Indurated, or hard, *Terra calcarea indurata*, lime-stone, *lapis calcareus*.

A. Solid, of no visible particles, or not granulated, *particulis impalpabilibus*.

This kind varies in regard to hardness and colour; for instance,

- a.* White, *chalk-stone*, from Hull in England.
- b.* Whitish Yellow, is dug at Balsberg in Skone in Sweden, and in the Venetian territories.
- c.* Flesh-coloured, found in loose masses in the corn-fields in the province of Upland in Sweden.
- d.* Reddish-brown, found in the island of Oeland, the province of Jemtland, at Rettwick in the province of Dalarna, and at Kimnekulle in the province of Westergottland in Sweden.

- e. Grey, at the same places.
- f. Variegated with many colours, found in Italy, at Blankenburgh, and many other places, and is particularly called Marble [z].
- g. Black, in the province of Jemtland in Sweden, and in Flanders.

S E C T. 8.

B. Grained or granulated limestone, *Lapis calcareus particulis granulatis*.

1. Coarse grained and of a loose texture. This is called *Saltslag* in Swedish, from its re-

[z] Though it may displease many, yet I must own, I cannot find any characters whereby a marble is to be distinguished from a limestone; and I insist upon it, that nothing but the colours and the texture of the particles distinguish the kinds of limestone. But as Nature has established no rank by colours, and has made all solid limestones equally capable of a polish, before they are spoiled by decaying or decomposing, it is, therefore, out of this species of solid limestone, that such as strike the fancy most, ought to be chosen for ornaments, under the name of Marble.

It belongs to the subterranean geographers to examine, if this solid limestone is ever found otherwise than in strata, and without being mixed with any heterogeneous bodies, that likewise have been changed into a calcareous substance. Here, in the northern parts of the world, it is only found in such a manner as shews it was formed in strata, by water's taking up and carrying its particles, and afterwards depositing them in form of a sediment, just as a slime or mud (which consists of the finest particles of pounded rocks) gathers together at the stamping mills; and as they are thus formed in the water, there always are heterogeneous parts along with them. These heterogeneous substances are, however, in too small a quantity, to be capable of having changed the whole mass into a calcareous substance (as some pretend); not to mention those circumstances, which, in other respects, make such an opinion very improbable. *Auth.*

resemblance to lumps of salt, and is found in the silver mines at Salberg, in the province of Westmanland in Sweden.

- a. Reddish yellow.
- b. White, both these varieties are found in the mines of Salberg. The grained flux spar is also sometimes called *Salt-flag*.
2. Fine grained.
- a. White, found at Salberg.
- b. Semi-transparent, from Solfatara in Italy, in which native brimstone is found.
3. Very fine grained. This is common limestone at Salberg.
- a. White and green, from the mine at Salberg called *Storgrufwa*.
- b. White and black from the mine at Salberg [a], called *Herr flans Bottn*.

S E C T. 9.

C. Scaly limestone, *lapis calcareus particulis squamosis sive spatosis, vel spathaceis. Limsten.*

1. With coarse or large scales.
- a. White, found at Garpenberg, a copper mine in the province of Dalarne in Sweden.

It is likewise found at Tunaberg, a copper mine in the province of Sodermanland; but with these different qualities, that it loses in a

[a] This species has often as beautiful colours as those commonly called marbles; but the texture and coherency of its particles will not admit of a good polish. *The Author.*

calcining

calcining heat forty per cent. of its weight; and exposed to the air, acquires a brownish efflorescence, a sign that it contains some iron, and is a medium between a limestone and the white iron ore called *flabl-steine*; it does not excite any effervescence with acids in its crude state.

b. Reddish yellow, from Finland.

2. With small scales.

a. White, from the parish of Tuna in Dalarne, in the marble quarries at Kolmorden in the province of Ostergothland, the parish of Lillkyrke in the province of Nerike, and at Remito and Pargas in Finland.

3. Fine glittering or sparkling.

a. White, from Carrara in Italy, and Pargas in Finland.

b. Of many colours. This variety makes out a great number of the foreign marbles [*b*].

S E C T. 10.

D. Lime or calcareous spar. *Lat.* Spätum calcareum. *Sw. Fr.* and *Germ.* Spath.

1. Of a rhomboidal figure.

a. Transparent, or diaphanous.

[*b*] This species of limestone takes a good polish, and is therefore used as marble whenever it is found of a fine colour.

It is besides to be remarked, that the grained and slaty limestones (sect. 8 and 9) are either found in veins, or else form whole mountains, without shewing any strata, or signs of petrefactions. *Aub.*

1. Refracting

1. Refracting spar. *Lat. Spatum Islandicum.*
Sw. Dubbellstein. Germ. Doppelstein.

This represents the objects, seen through it, double [c]. It is found at Brattfors, an iron-mine in the province of Weroneland, in Switzerland, and Iceland [d].

2. Common spar, which shews the object single.

1. White, or colourless.
2. Yellowish and phosphorescent [e]. This is found at Jonuswando in Torneo Lappmark in the Swedish Lapland.

b. Opaque, *Spatum romboidale opacum.*

1. White, is found in many places, mostly in clefts, and among crystallisations.
2. Black, from Winorn at Kongsberg in Norway.

[c] I have found various pieces of the Derbyshire-spar, through which the light of a candle formed many images, some shewing 8, some 12, or 16, and even more images at once. Roch-cristal is well known to have also a double refraction, of which property Mr. Rochon, of the Royal Academy of Sciences at Paris, availed himself to make a new kind of micrometer for astronomical observations. And lastly Mr. Fromond, professor of natural philosophy at Milan, has lately observed the same effect of a double refraction in common plate-glass, whenever many parallel lines have been cut in its surface, by a diamond, at the distance of one five hundredth, or one thousandth part of an inch from each other: I have myself seen a piece of plated glass cut in this manner by the same gentleman, which produced the phenomenon abovementioned. *Edit.*

[d] Its specific gravity is 2,720. *Newt. and Waller.*

There are vast quantities of refracting spar (a variety of the Islandic) found in the lead mines of Derbyshire, Wales, and many other parts of England. *D. C.*

[e] This species probably contains the sparry acid; if so, it belongs to those in sect. 22. *Fabr.*

3. Brownish

3. Brownish yellow, at Salberg.
 1. Foliated or thin plated spar, *Lamellosum*.

This has no rhomboidal figure, but breaks into thin plates so placed as to be not unlike sheets of thin paper, laid over each other.

- a. Opaque white, *Spatum lamellosum opacum*, from Winorn at Konigsberg, and Scara-grufvan at Egeren in Norway.

S E C T. II.

E. Crystallised calcareous spars [*f*] spar drusen.

[*f*] The name spar is very well known, and only used to determine a certain figure, viz. when a stone breaks into a rhomboidal, cubical, or a plated form, with smooth and polished surfaces, it is called spar; and as it is thus applied to stones of different kinds, without any regard to their principles, one ought necessarily to add some term to express the constituent parts at the same time as the figure is mentioned; for instance, Calcareous Spar, Gypseous Spar, Flux Spar, Short or Cockle Spar, &c. This term, however, is not applied but to earths, and such ores as are of the same figure as the Lead Spar, &c.

All crystallised spars, when broken, shew the sparry figure in their particles, and the crystallisation is to be ascribed to the empty space left by the contraction of the sparry principle: such holes filled with Drusen of spars, are in Swedish called *Drake*, or *Druse-hol* *.

The figure of the crystals varies more in this genus than in any other, for which no reason can be assigned; it ought not to be ascribed to salts, as long as the presence of any such cannot be proved: but there are strong indications to suspect, that other substances may likewise have received the same property

* The name of spar is never used with such a latitude in our language. Those of this flakey texture were, by our former writers, as Grew and Woodward, called talcy spars; but that term now is justly exploded. *D. C.*

fen [g]. *Lat.* Lapis calcareus crystallifatus. *Swed.* Spat-crystaller, spat druser. *Fr.* Spath cristallisé en groupes. *Germ.* Spath cristallen, spath drusen.

It is contained under several planes or sides, from the relative positions of which many different figures arise, that have not all been fully observed, nor can they be exactly described. The following are therefore mentioned, only as instances of the most regular and common kinds, viz.

1. Transparent, *spatum drusicum diaphanum.*
- a. Hexagonal truncated, *crystalli spatosi hexagoni truncati.* This is found at the Hartz

to assume an angular surface on certain occasions. See Mr. Cronstedt's Introductory Speech at the Royal Academy of Sciences at Stockholm.

Besides, the consideration of those figures is a thing of more curiosity than of real use, because no miner has yet been able to make any conclusion relative to the quantity or quality of the ores, from the difference of the figures of spars found along with them; and the grotto makers never take any notice of the angles or sides, but think it sufficient for their purpose, if they make a fine or glittering appearance at a distance.

It would, nevertheless, be well if any one would take upon himself the trouble to observe, whether each species of spar has not a certain determinate number of figures or sides, within which it is confined, in its accretions. This has hitherto been impossible to do, because all species of spars have been confounded together, without regard to their different principles: though, for my part, I do not think it of any great consequence. *Auth.*

[g] I have adopted this German term of *Drusen* into our English language, for a cluster of regular figured bodies, as a groupe conveys the idea of a cluster only, whether regular or of indeterminate figures. *D. C.*

in Germany, and at Jonufwando in Lapland.

b. Pyramidals, *pyramidales*.

1. Dog's-teeth, *pyramidales distincti*. Found at Salberg, and in the iron mines at Danemora in the province of Upland.

2. Balls of crystallised spar, *pyramidales concreti* [*b*].

These are balls which consist of concentric octaedral pyramidal spar crystals, they are found at Rettwick in the province of Dalarne and other places.

S E C T. 12.

F. Stalactitical Spar, *Stalactites Calcareus*.
Stalactites, Stone Icicle, or Drop-stone.

This is formed from water saturated with lime, which, while running or dropping, deposits by degrees the calcareous earth which it has carried along with it from clefts of rocks, or from out of the earth. It is therefore commonly of a scaly, though sometimes of a solid and sparry texture. Its external figure depends on the place where it is formed, or the quantity of the matter contained in the water, and other like circumstances.

1. Scaled stalactites of very fine particles, *stalactites testaceus particulis impalpabilibus*.

a. Of a globular form, *S. testaceus globulosus*.

[*b*] The concave figured spar balls in the quarries of Somersetshire and other counties in England. Such balls of freestone are not unfrequently found. *D, C.*

1. White,

1. White, the pea-stone from Carlsbad, in Bohemia.

2. Grey, *Pisolithus*, *Oolithus*, from Gottland in Sweden [i].

b. Hollow, in the form of a cone, *Coniformis perforatus*.

1. White, is found every where in vaults made with mortar, and through which water has had an opportunity to penetrate; and also in grottos dug in rocks of lime-stone.

c. Of an indetermined figure, *figura incerta*. *Sinter*. From the cavern called the Baumanns-hole in the Hartz, the aqueduct at Adrianople, in Italy, and elsewhere*.

d. Of coherent hollow cones, *Conis concretis excavatis*. Of this kind is a stalactitical crust which has formed a stratum, or rather filled a fissure between the strata of the earth at Helsingborg in the province of Skone; it is of a very singular figure, resembling conical caps of paper placed and fixed one in another, diminishing by degrees both in height and other dimensions [k].

[i] Also the Hammites, from its resemblance to the roes or spawn of fish. It has been exhibited by authors as petrified roes. The Ketton freestone of Rutlandshire is a remarkable stone of this sort. *D. C.*

[k] This species is likewise found in the neighbourhood of Peterwalde, in Lower Saxony. *Brun.*

* Especially in all hot baths. *Brun.*

2. Solid stalactites of a sparry texture, *stalactites solidus particulis spatosis* [1].

a. Hollow, and in form of a cone, *coniformis*.

1. White and semitransparent from Chaceline near Rouen in France [m].

[1] In making lime-water (*aqua calcis vivæ*) one may observe how the lime gathers, first like a pellicle on the surface of the water, and afterwards, when this breaks, falls down to the bottom in form of a scaly sediment, which is called *cremor calcis*: after that, a new pellicle is formed, which likewise falls down; and in this manner it continues for a long while, although the lime-water had before been passed thro' a filtre. This we may also imagine to be the way in which the works of Nature are performed: whence the stalactites commonly is of a scaly texture, or at least discovers some tendency towards it. But a stalactites of a sparry texture, such as above-mentioned from Rouen, may be supposed to be owing to a more copious principle concurring at once: and in the same manner the sparry limestone and its crystallisations seem likewise to have been produced, since they, as far as I know, are only found in clefts, which, when they have been filled up with a stony matter, the Swedish miners call *Klyfter*, and *Gangar* or *Veins*. In regard to this, the stalactites, the sparry limestone, and also its crystallisations, might all be ranked under the same title in a systematical description, as very little different from one another, if it was not necessary, in describing mines and other works, to give them their separate names: because it is certain, that a piece which is broken from large spar-crystals, or from sparry stalactites, may in a cabinet pass extremely well for a common sparry limestone, without leaving any suspicion of its former figure, before it was broke. *The Author*.

[m] 3. Solid stalactites, of a radiated texture.

a. In form of corals.

1. White, abounds in the caverns of the steel-mines in Upper Stiria, and more scarce in the shaft of *Backen*, near Chemnitz in Hungary. *Brun*.

S E C T. 13.

B. Calcareous earth, combined with vitriolic acid. Plaster-stone. Parget. *Lat.* Terra calcarea acido vitrioli saturata. Gypsum. *Sw.* Gyps arter. *Fr.* Gypse. Platre. *Germ.* Gypsarten [*n*]. This is

1. Looser and more friable than a pure calcareous earth.
2. Either crude or burnt, it does not excite any effervescence with acids, or at most it effervesces but in a very slight degree, and then only in proportion as it wants some of the vitriolic acid to compleat the saturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being made red-hot, its powder readily concretes with water into a mass which soon hardens; and then
5. No heat is perceived in the operation,

[*n*] Plaster contains about half of its weight of vitriolic acid, viz. $\frac{1}{2}$ of this acid, $\frac{1}{2}$ of pure calcareous earth, and $\frac{1}{2}$ of water. It is soluble in 500 times its own weight of warm water, or 450 of boiling ditto, (*Berg. de Analyſi Aquarum* :) from whence it appears that it should be placed among salts. It is well known by the property it has of forming, after a slight burning, a hard mass with water. In the act of this mixture some heat is produced, though much less than when lime is mixed with water. *Berg. Scia.* § 59.

Plaster is often employed in building: it may also be taken off afterwards, and by burning, again and again, be made fit for use. *Theoph. on Stones*, § 115.

6. It is nearly as difficult to be melted by itself as the limestone [o], and shews mostly the same effects, with other bodies, as the limestone: the acid of vitriol seems however to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fusion, owing to the nature of both the salts [p].
8. Burnt with any inflammable matter it emits a sulphureous smell, and may as well by that means, as by either of the fixed alkaline salts be decomposed: but for this purpose there ought to be five or six times as much weight of salt as of gypsum.
9. Being thus decomposed the calx or earth which is left, shews commonly some marks of iron.

[o] I have found most of the gypseous kind, and particularly the fibrous, to melt pretty easily by themselves in the fire.

[p] When a small quantity of any gypsum is melted together with borax, the glass becomes colourless and transparent, (see note b § 4,) but I have found some sorts of alabaster and sparry gypsum that, when melted in some quantity with borax, yield a fine yellow transparent colour, resembling that of the best topazes.

This phenomenon might probably happen with every one of the gypseous kind. But it is to be observed, that if too much of such gypsum is used in proportion to the borax, the glass becomes opaque, just as it happens with the pure limestone. See the following *Treatise on the pocket Laboratory*. E.

S E C T. 14.

The gypseous earth is found.

1. Loose and friable, *terra gypsea pulverulenta*. Gypseous earth, properly so called, *Gubr.*
- a. White, is found in Saxony.

S E C T. 15.

2. Indurated, *terra gypsea indurata*.

A. Solid, or of no visible particles, *solida particulis impalpabilibus*. Alabaster, *alabastrum*.

This stone is very easy to saw and cut, and takes a dull polish. It is not always found saturated with the acid of vitriol.

- a. White, alabaster.

1. Clear and transparent, from Persia.

2. Opaque, from Italy; and Trapano in Sicily.

- b. Yellow.

1. Transparent, from the eastern countries.

2. Opaque [q].

S E C T.

[q] In Spain we find this, and several other varieties of alabaster, which is very fine. The ancients have probably got their beautiful alabasters from thence. *Brun.*

Great

S E C T. 16.

B. Gypsum of a scaly structure. *Gypsum particulis micaceis*. This is the common plaster of Paris.

1. White coarse scales.
 - a. White, this is found in the copper mines of Ardal in Norway, where this stone is the country, or bed of the copper ores.
2. With small scales.
 - a. Yellowish, from Montmartre near Paris.
 - b. Greyish, from Sperenberg in the Mark in Germany.

S E C T. 17.

C. Fibrous gypsum, or plaster-stone, *gypsum fibrosum, alabastrites*.

1. With the fibres coarse.
 - a. White, from Livonia.
2. With fine fibres.
 - a. White, is found in thin strata between the alum slates at Andrarum in the province of Skone.

Great variety of fine alabasters are found in Italy: at Volterra alone no less than twenty-four quarries of them, each of a different colour, are now worked out. The Romans however brought from Greece the greatest part of those alabasters they made use of. *Fabr.*

S E C T. 18.

D. Spar like gypsum, *selenites*. This by some is also called *glacies mariæ*, and is confounded with the clear and transparent mica.

1. Pure selenites.

Transparent, *spatum gypsum diaphanum*.

a. Colourless, from Swifferland.

b. Yellowish, from Mont-martre near Paris.

N. B. The marmor metallicum, which the author has inserted in this section, belongs to sect. 40.

This and some other minerals of this kind described by the noble author of this mineralogy, contain the ponderous earth, which properly constitutes the second Order of earths, as has been hinted in the note m to sect. 3. and for this reason will be put separately in sect. 40. See Berg. Scia. § 89.

S E C T. 19.

E. Crystallised gypsum, *gypsum crystallisatum*.

Gypseous drusen, *drusæ gypseæ*.

1. Drusen of crystals of pure sparry gypsum.

See § 18. n. 1.

A. Wedge-formed, *cuneiformes*, are composed of a pure spar-like gypsum, from St. Andreasberg.

1. Clear and colourless, from Switzerland.
 2. Whitish yellow, from Montmartre.
- B. Capillary, capillares.*
- a.* Opaque, whitish yellow, from Stollberget in Kopparbergslän in Sweden [*r*].

N. B. *The three spars here described by the author, under the species of marmor metallicum drusicum: viz. the jagged, the white, and the reddish, are inserted in the additional Order of earths sect. 46. to which they properly belong.*

S E C T. 20.

F. Stalactitical gypsum. Stalactites gypseus. Gips finter. This, perhaps, may be found of as many different figures as the calcareous stalactites or finters. See § 12. *c.*

I have only seen the following, viz.

1. Of no visible particles, *particulis impalpabilibus*, in French *Grignard*.
- A.* Of an irregular figure.
- a.* Yellow, from the plaster-pits at Montmartre near Paris.
 - b.* White, from Italy.

[*r*] *b.* Hexagonal, Prismatic, in Normandy.

c. Globular, consisting of cuneated rays, proceeding from the centre. *Brun.*

This is used in several works, as alabaster, especially when it is found in large pieces; and then it commonly varies in colour between white and yellow, as also in transparency and opacity.

2. Of a spar-like texture, *Textura spatosa*.

A. In form of a cone.

a. White and yellow, from Trapano in Sicily.

B. Of an irregular figure.

a. White, from Stollberg in Kopparbergslän in Sweden [s].

[s] What has been before observed (sect. 11, 12.) about accreted *spars* and *sinter*, may also be applied to this species. *The Author*.

Gypseous fossils abound in England. Plaster stone, granulated, and solid. Some are so very fine as to be alabaster: that is, take a smooth surface and politure. There are plenty of this kind in Derbyshire and Nottinghamshire, where are large pits of it; and also in most of the cliffs of the Severn, especially at the Old-Passage in Somersetshire. A very fine semipellucid solid alabaster is found in Derbyshire. Fibrous talcs, very fine, are found in the same pits of plaster-stone abovementioned, and many other places. Selenites of many kinds abound in England in clays, insomuch that it is needless to enumerate the places. Very fine gypseous Drusen are found in Sheppy-isle; and the most beautiful I have ever seen, perfectly pellucid as cristal and large, has been dug from the salt-rocks at Nantwich in Cheshire. The Selenites Rhomboidalis, a rare fossil in other countries, is frequently found in England; but Shotover-hill in Oxfordshire, is famous for them. I do not know of many of the spar-like gypsea of English product; but the Isle of Sheppy affords a kind (to my knowledge peculiar and particular to that small spot of ground, and not found any where else in the world) fibrous, and always accreting in radiations like a star on the septaria, thence called *Stella Septarii*. D. C.

SECT.

S E C T. 21.

G. Calcareous earth satiated with the acid of common salt. *Terra calcarea acido salis communis saturata. Sal ammoniacum fixum naturale.* Saltska.

This is found.

1. In sea water.

2. In salt pits.

It is formed in great quantities at the bottom of the salt-pans of the salt works.

It attracts the moisture of the air [1].

[1] Perhaps some kinds of lime-stones may exist that contain more or less of the acid of common salt, though they are not yet discovered. It is almost incredible what quantity of such dissolved calcareous earth is contained in sea-water; and from which the testaceous animals get the materials for their shells or coverings.

Perhaps nature has a particular and secret method of producing a mineral alkali out of the calcareous earth, and has thus laid this earth, as well as the acid of common salt, together in the water, in order to combine them by degrees, and produce the common salt. *The Author.*

S E C T. 22. (97 of the Author.)

“ Calcareous earth combined or saturated
 “ with sparry acid, known by the name of
 “ *sparry fluor*, and blue john [*u*]. *Lat.* Fluor
 “ *spatosus*. Fluor mineralis. Terra calcarea
 “ *acido spatoso saturata*. Muria chrysolampis
 “ *Linnæi* (vel potius *B. à boot*). *Swed.* Fluf-
 “ *ser*, flufs-arter. *French*, Fluors. Spaths vi-
 “ treux. Spaths fusibles. *Germ.* Flusse, flufs-
 “ spath. Flufs arten [*w*].

These are commonly called fluxing [*x*], vi-
 trescent, or glass-spars; because most part of
 them

[*u*] These bodies were ranged by the author in his *fixth*
order of minerals: but later discoveries (see Berg. Sciagr.
 § 96.) have demonstrated that their basis is the calcareous
 earth, combined with the sparry or fluor acid, whose existence
 has been ably vindicated by its discoverer the famous Mr.
 Scheel of Sweden, against the objections of Mr. Monet, and
 others under the name of Boulanger. See the translation of
 this vindication in Journal de Physique for April 1783, p. 265.
The Editor.

[*w*] *Calx fluorata* (calcareous earth and fluor acid), when
 pure, is wholly soluble in nitrous and muriatic acids. Ex-
 posed to heat, below ignition, it emits a phosphorescent light.
 Fluor acid, dropped into lime-water, precipitates a powder
 which has all the properties of the *calx fluorata*. It is some-
 times, but not always, contaminated by a small proportion of
 filiceous earth and muriatic acid. Berg. Sc. § 98.

Acids, in a state of ebullition, particularly *aqua regia*, dis-
 solve them in some degree: and an alkaly (even cold, though
 not so compleatly) precipitates these solutions. *Fabr.* I
 have

them have a sparry form and appearance: they are, however, often met in an indeterminate figure [x].

They are only known in an indurated state, and distinguish themselves from the other earths, by the following characters [y].

1. They are scarce harder than common calcareous spars and consequently do not strike fire with steel.
2. They do not ferment with acids neither before nor after calcination.
3. They do not melt by themselves; but crack and split to pieces when exposed to a strong fire [z]. But
4. In mixtures with all other earths they are very fusible, and especially with calcareous

have dissolved them often with boiling vitriolic acid, to get the sparry acid under an aerial form, within a vessel of quicksilver, where the admission of common water reduces this kind of air into earth, as Dr. Priestley discovered some few years ago. *The Edit.*

[x] I have adopted the name of *fluors* in English, to this order. *D. C.*

They are called *fluors* from their comparatively ready fusibility, which makes them be used, particularly in England, as flux for lead-ores, whose veins they generally accompany. *Fabr.*

[y] Their specific gravity is, 3,144, and even 3,175. *Wall.*

[z] There may, perhaps, be some fluors, that are pretty refractory in the fire, so as not to be melted: however, all those which I have tried, have melted pretty easily by the blow-pipe; but I have always taken great care in these experiments, that they might not fly away, before they were heated through. *Eng.*

earth

earth with which they melt into a corroding glass that dissolves the strongest crucibles, unless some quartz or apyrous clay be added thereto [a].

5. When heated slowly, and by degrees they give a phosphorescent light: but as soon as they are made red-hot, they lose this quality. The coloured ones, especially the green, give the strongest light, but none of them any longer than whilst they are well warm.
6. They melt and dissolve very easily by the addition of borax; and, next to that, by the microcosmic salt, without ebullition.

S E C T. 23. (98 of the Author).

A. Indurated fluor, fluor mineralis induratus.

1. Solid, of an indeterminate figure, *fluor particulis impalpabilibus, figurâ indeterminatâ.*

Is of a dull texture, semi-transparent, and full of cracks in the rock.

- a.* White, found in Batgrufvan, at Yxjö in Nya Kopparberget in Westmanland.

[a] See note *u* to § 4.

S E C T. 24. (99 of the Author).

2. Sparry fluor, *fluor-spatosus*.

It has nearly the figure of spar; though, on close observation, it is found not to be so regular, nothing but the glossy surfaces of this stone giving it the resemblance of spar.

- a. White, found in Stripas at Norberg, in the province of Westmanland.
- b. Blue, from Norrgrufve, at Westersilfverberget in Westmanland.
- c. Violet, from Diupgrufvan, at the last mentioned place, and also from Stripas and Foggerlid; and Gislöf in the province of Skone.
- d. Deep green, from Stollberget in Stora Kopparbergslän.
- e. Pale green, from Kuppgrufven, at Garpenberg in the province of Dalarne.
- f. Yellow, from Gislöf in Skone.

S E C T. 25. (100 of the Author).

3. Crystallised fluor, *fluor crystallifatus*.

1. Of an irregular figure.

a. White.

b. Blue, both from Norberget and Norberg in Westmanland.

c. Red, from Heslekulla iron-mine, in the province of Nerike.

2. Of a cubical figure.
 - a. Yellow, and
 - b. Violet, from Giflos in Skone, Blyhall in the parish of Barkaro in the province of Westmanland.
3. Of a Polygonal spherical figure.
 - a. White, from Bockbackeveggen in Falun copper-mine in Dalarne.
 - b. Blue, from Bondgrufvan, at Norberg in Westmanland.
4. Of an octoëdral figure.
 - a. Clear, colourless. This I have seen in the collection of the mine-master Mr. Von Swab [a].

S E C T. 26. (101 of the Author).

Observations on Fluors.

That which causes the phosphorescent light (§ 22. N° 5.) vanishes in the fire, it being impossible to collect it, by any method we are yet

[a] "In Hungary and Transilvania are no fluors; there are some in Saxony, yet not in sufficient quantity to be used in melting of ores. Upon the Hartz, and especially near Stollberg, there are some veins of it, of the width of several fathoms. From this place they sell it to the copper works of Mansfield and parts adjacent, where they use it as a flux to their refractory slate." *Brun.*

acquainted

acquainted with. It cannot therefore be asserted, whether it is one of the constituent parts necessary to the composition of these stones, or if, in regard to its small quantity, it even deserves any attention. I take it to be a subtle phlogiston, which being modified in various manners, gives rise to such various colours.

At mineral works this kind of stone is very useful in promoting the fusion of the ores, and is therefore as much valued by the smelters as the borax is by the assayers: it has also from this quality got the name of fluor, or flux [b].

[b] That these sparry fluors are but a combination of calcareous earth with the *fluor acid*, is evidently demonstrated, both by the chemical analysis of these substances, and by their synthetical production. In the first case, the sparry acid is expelled from these spars by any of the three mineral acids; but more easily by the vitriolic acid. This acid (the sparry) for the most part is developed in the form of an elastic vapour, which, according to Messrs. Scheele and Bergman, forms a *siliceous earth* as soon as it comes in contact with water, or even with vapour of water. And if the same sparry acid is joined to calcareous earth, true sparry fluors are produced; which synthetically demonstrates their real component principles. *Fabr.*

But Mr. Meyer, of Stetin, has shewn that the opinion of Messrs. Scheele and Bergman (viz. that the *fluor acid* produced *siliceous earth* when in contact with water) is erroneous; and Mr. Bergman has acknowledged the mistake with a degree of readiness and candour that reflects the greatest honour on his character, in a letter I received from this great philosopher, dated December 24, 1782. The cause of this mistake proceeds from the property which the *fluor acid* possesses of volatizing the *silicious earth*, contained either in the glass retort, or in the *sparry fluor* when it is expelled by the vitriolic and in that operation above-mentioned by Mr. Fabroni. *Edit.*

The resemblance between the coloured fluors, and the compositions made of glass, has perhaps contributed not only to the fluors being reckoned of the same value as the coloured quartz crystals, by such collectors as only mind colour and figure; but to their also obtaining a rank among the precious stones in the apothecaries and druggists shops [c]. They however may be permitted to enjoy that honour, since our modern physicians do not make more use of them than of the others.

SECT. 27. (210 of the Author).

Calcareous earth saturated with a particular acid, perhaps of the metallic kind, (*viz.* the Tungstenic acid). *Calx acido peculiari, forte metallico satiata* [d]. The Tungstein of the

[c] This combination of *calcareous earth* with the *sparry acid* is almost always transparent: it often crystalises in regular cubes, sometimes single from one line to two inches in diameter, and sometimes of an indeterminate figure. They are sometimes of a blue colour, others are purple like amethysts; some are of a brown colour, and some are opaque. *Fubr.*

[d] The author says that this substance is a calx of iron, united with another unknown earth, *Ferrum calciforme terrâ quâdam incognitâ intimè mixtum*. But both Scheele and Bergman, after the exact analysis made by each of them separately of this ore, decisively affirm, that its basis is merely a *calcareous earth*; and that it is combined in this ore with the *Tungstenic acid*, which was unknown in the time of the author; but it will be described hereafter in Sect. 163. It is evident, therefore, that this ore ought never to be called *Lapis ponderosus*, which conveys the wrong idea of belonging to the *ponderous earths* of the second order, Sect. 48. See Bergm. *Sciagr.* § 97. and *De Turbo Ferrum.* § 17. but more particularly in their own accounts, inserted in *Journ. de Physiq.* for February 1783, p. 124 and 128.

Swedes

Swedes [e]. This is also, though improperly, called white Tingrains [f].

This resembles the garnet-stone (of Sect. 115), and the tin-grains; is nearly as heavy as pure tin; very refractory in the fire, and excessively difficult to reduce to metal. Iron has, however, been melted out of it to more than thirty per cent. [g]. It is very difficultly dissolved by borax and alkaline salts, but melts very easily with the microcosmic salt, giving a black slag: and for this reason, the last-mentioned salt must be employed in the essays of this stone. It is found,

1. Solid and fine-grained.
- a. Reddish or flesh-coloured.

[e] The specific gravity of this substance is 3,600. Berg. in *Journ. de Phys.* Feb. 1783, where may be seen the analysis of this substance, both by the same professor, and by Mr. Scheele.

This substance is not very soluble in acids, and is easily known by reducing it into powder, and digesting it over the fire with muriatic acid; because it will soon take a fine yellow colour. Besides calcareous earth, it contains also some portion of silicious earth. *The Edit.*

[f] This mineral, called *zin graupen* by the Germans, commonly named white tin ore, or *white crystals of tin*, is very often nothing else but a true *tungstein*, from whence it appears the absolute necessity of a chemical analysis to distinguish one ore from another. *The Edit.*

[g] In all probability these were true crystals of *garnets*, though similar to the *tungstein*: as Mr. Scheele above quoted could hardly find two grains of Prussian blue in a considerable solution of this last substance. *The Edit.*

- b.* Yellow, from Bastnasgrufva at Riddarshyttan in the province of Westmanland.
- 2. Spathose, and with an unctuous surface.
- a.* White, from Marienberg and Altenberg, in Saxony.
- b.* Pearl-coloured, from Bispsberg Klack, in the province of Dalarne [*b.*]

SECT. 28. (22.)

D. Calcareous earth united with the inflammable substance [*i*]. *Terra calcarea phlogisto mixta, seu impregnata.*

These

[*b*] This kind of stone is very seldom met with; but in such places where black lead is common in the neighbourhood; and the history of the black lead, inserted in the Memoirs of the Swedish Academy of Sciences, has induced me to believe, that this may contain some tin, which merits further examination. Mr. Cronstedt has in the said Memoirs communicated his experiments upon this kind of stone from Riddarshyttan, and Bispsberget in Westmanland; as has also Mr. Rinman, on a great number of other martial earths. See the said Memoirs for the years 1751 and 1754. *The Author.*

Although the Tungstein be generally found in or near the mines of *Molybden*, and *black lead*; the metallic acid which unites with its calcareous basis is far different from the Molybdenic acid, notwithstanding that some of their properties are similar in them both: as will be seen in Sect. 162 and 163. *The Editor.*

[*i*] *Calx aerata* (*mild calcareous earth*), with more or less *petroleum*. It effervesces, and dissolves with acids; with the vitriolic acid it frequently turns brown. Is foetid when heated or rubbed. The oil is not in sufficient quantity to be collected,

These have a very offensive smell, at least when they are rubbed and receive their colour from the phlogiston, being dark or black in proportion as it predominates.

S E C T. 29. (23.)

1. Calcareous earth mixed with phlogiston alone. *Terra calcarea phlogisto simplici mixta.*
Lapis suillus. Foetid stone and spar, or swine stone and spar. Perhaps the smell of this stone may not be so disagreeable to every one: it goes soon off in the fire. Its varieties in regard to texture are as follows:

A. Solid, or of no visible or distinct particles. *Solidus particulis impalpabilibus.*

a. Black, the marble dug in Flanders, and in the province of Jemtland in Sweden.

B. Grained. *Particulis granulatis.*

a. Blackish brown, from Wretstrop at Skoers in the province of Nerike.

C. Scaly, *Particulis micaceis.*

i. With coarse scales.

a. Black, at Nas in Jemtland.

lected, by distillation, in drops; it only fouls the inside of the vessels, unless a very great quantity be operated upon. In an open fire the colour presently vanishes, from the petroleum drying up. It generally contains a portion of martial clay. *Berg. Sc. § 95.*

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E

2. With

2. With fine glittering on sparkling scales.

a. Brown from Kinnekulle in the province of Westergottland and Rettwick in the province of Dalarne.

D. Sparry.

a. Black.

b. Light brown.

c. Whitish yellow, found in the slate rocks, in the province of Westergottland.

E. Crystallised.

1. In a globular form, dug up at Krasnasele in Ingermanland [k].

N. B. *The mineral described in the 24th section of the Author as belonging to the calcareous earths, being now acknowledged, as belonging to the ponderous earth [l], will be inserted in that order of earths.*

S E C T. 30. (25.)

E. Calcareous earth blended with an argillaceous earth. Marle. *Lat.* Terra calcarea argilla intimè mixta. *Marga. Swed.* Mergelarter. *Fr.* Marne. *Germ.* Mergel.

[k] Many of the limestones of England are of this section, being extremely foetid when violently struck. In regard to the foetid spars, I have had them from the lead mines of Flintshire in Wales. *D. C.*

[l] Berg. Sciagr. § 90.

1. When

1. When crude, it makes an effervescence with acids [*m*], but
2. Not after having been burnt, by which operation it is observed to harden in proportion as the clay exceeds the calcareous substance.
3. It easily melts by itself into a glass, and even when it is mixed with the most refractory clay.
5. It is of great use in promoting the growth of vegetables, since the clay tempers the drying quality of the calcareous earth.
6. When burnt in a calcining heat, it readily attracts water: and exposed to the air, in time it falls into a powder. The varieties of this kind, worthy to be taken notice depend on the different quantities of each of their component parts, and on the quality of the clay.

I shall for instance specify the following examples.

[*m*] If marle be put into fused nitre, it does not make any detonation, but it is decomposed by the same.

Every *argillaceous* earth, mixed with one quarter of its weight of *calcareous* earth, is called marle. *Fabr.*

S E C T. 31. (26.)

1. Loose and compact. *Marga friabilis*.

This diffuses in water like common clay.

a. Reddish brown, dug up in the island of Gottland in Sweden.

b. Pale red, dug up at Upsal in Sweden. This when burnt is of a yellowish colour, and used for making the earthen-ware in the potteries at Rorstrand near Stockholm.

S E C T. 32. (27.)

2. Semi-indurated. *Marga indurata aëre fatiscens*.

It is nearly as hard as a stone when first dug up, but moulders in the open air. It is mostly slaty, and it is not uncommon in the slate rocks of Sweden, where it lies between the thick beds of slaty limestone. It is also found by itself forming very thick strata. It does not dissolve in water, till, by a considerable length of time, it has mouldered to a powder.

a. Grey.

b. Red.

These are found at Styggforsen in the parish of Rettwick in the province of Dalarne.

S E C T.

S E C T. 33. (28.)

3. Indurated or stone marle, *Marga indurata*.
A. In loose pieces, *Marga indurata amorphæ*; by the Germans called *Duckstein* or *Tophstein*.
a. White, from Woxna in Carelen, and in the river at Nykioping in the province of Sodermanland.
b. Grey, found in the provinces of Angermanland and Skone. It is formed from a sediment which the water carries along with it.
B. In continued strata, *Marga indurata stratis continuis*. Hard flaty marle.

S E C T. 34. (Additional.)

Observations on Marle and arable Soil.

It is probable that the good effects of marle in agriculture proceed from its containing an earth soluble in water, and that it serves to hasten or facilitate the decomposition of vegetable or animal substances that may be mixed therewith, rendering their oily parts mucilaginous, and soluble in water, and thereby capable of penetrating into the pores of the roots of plants: it may also hinder the propagation of

insects. Besides I believe it contributes much to vegetation by furnishing aerial acid or fixed air which it may afterwards reassume from the atmosphere. *Fabr.*

The efficacy of marle, as a manure in agriculture, has been explained at large in a book published a few years ago at Paris, with the title *Reflexions sur l'Agriculture* in 12mo. to which the author (Mr. J. Fabroni) out of modesty did not prefix his name. *The Edit.*

English farmers distinguish six sorts of marle.

1. The *Coro-shut marle*, which is brown mixed with fragments of chalk and blue veins.

2. *Stone slate*, or flag-marle, it resembles blue slate and crumbles easily when exposed to the air.

3. *Pont marle*, or delving marle, it is brown and rough to the touch.

4. *Clay-marle*, which contains much clay.

5. *Steel-marle*, it is of an ash grey colour, and breaks in cubes.

6. *Paper-marle*, its colour is black, its consistence like that of bits of paper. *Fabr.*

It is however highly probable, that the good effects of marle in agriculture, depend from the circumstances of the soil, by supplying it with that part of *clay* and *chalk*, which is wanting to make up the best proportion of its component parts. That this is the case in many instances, is evident by the judicious experiments of professor Bergman, which show, that, in Sweden, the best arable land of a flat ground, where about 15 inches of rain fall yearly, contains 4 parts

parts of *clay*, 3 of *siliceous* earth or *sand*, 2 of *chalk*, and 1 of *magnesian* or *soapy* earth, viz. that which constitutes the basis of Epsom salt. These proportions must vary according to the local circumstances of the ground and climate of each country. But after the discovery of such a leading principle, no rational farmer can be excusable hereafter, if he does not take the necessary steps to ascertain the most advantageous proportion of these component parts, that are suitable to his soil, and does not improve it accordingly, by employing such manures as tend to supply their deficiency. The above learned Professor practiced this method in his own country to the utmost advantage: and there is not the least doubt but the general ignorance of farmers in this respect has been the cause of continued blunders, and numberless wrong practices in husbandry such as throwing *chalk* or *lime* on grounds which wanted *clay*, or *sand*, and the like. By such blind proceedings many valuable means of rural improvement have been brought to common discredit, which if properly applied would be extremely profitable in their respective circumstances [n]. *Edit.*

SECT,

[n] The Society for the encouragement of arts, manufactures, &c. in London, has offered, at my request, a premium in this year (1783) for this purpose, which I hope will be attended with great advantage to the British agriculture: it runs thus. "To the person who shall produce to the Society the most satisfactory set of experiments to ascertain the due proportion of the several component parts of the best arable land

S E C T. 35. (29.)

F. Calcareous earth united with a metallic calx, *Terra calcarea metallis intimè mixta.*

Here, as well as in the others, such a mixture or combination is to be understood, as

“ in one or more counties in Great Britain, by an accurate analysis of it; and who having made a like analysis of some poor land, shall by comparing the component parts of each, and thereby ascertaining the deficiency in the poor soil, improve a quantity of it not less than two acres, by the addition of such parts as the former experiments have discovered to be wanting therein, and therefore probably the cause of its sterility, the gold medal.

“ It is required that the manurings, plowings, and crops of the improved land be the same after the improvement as before: and that a minute account of the produce in each state; of the weather, and of the various influencing circumstances together with the method made use of in analysing the soils, be produced with proper certificates; and the chymical results of the analysis, which are to remain the property of the Society, on or before the last Tuesday in November 1788.

“ It is expected that a quantity not less than six pounds of the rich, of the poor, and of the improved soils, be produced with the certificates.

“ N. B. Among the methods or processes made use of by chymists and called *dry*, or *moist*, the latter appears only adapted to the ascertaining the respective proportion of the component parts of arable earth. Dr. Shaw in his *Chymical Lectures*; Dr. Home in his *Principles of Agriculture*; Dr. George Fordyce in his *Elements of Agriculture*, and Sir Torbern Bergman in his *Dissertation Sur les Terres Goniques*, have treated of these subjects.” See the Transactions of the Society for the Encouragement of Arts, &c. for 1783, in 8vo. p. 94. *The Editor.*

cannot

cannot be discovered by the eye alone, without the help of some other means.

The subjects belonging to this division lose the property of raising an effervescence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found some that contained twenty or thirty per cent. of metal, and yet have shewn their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with calcareous earth, viz.

S E C T. 36. (30.)

1. Calcareous earth united with iron, *Terra calcarea marte intimè mixta*. White spar like iron ore, *Minera ferri alba*. The *Stahlstein* or *Weisses Eisenerz* of the Germans,
1. This ore, however, is not always white, but commonly gives a white powder when rubbed.
2. It becomes black in the open air, as likewise in a calcining heat.
3. In this last circumstance it loses thirty or forty per cent of its weight, which by distillation has been found owing to the water that evaporates; and it is possible that some small quantity of vitriolic acid may, at the same time, evaporate with the water.
4. It

4. It is of all the iron ores the most easy to melt, and is very corrosive when melted. This is found,

S E C T. 37. (31.)

A. Loose, Minera ferri alba pulverulenta, which is the mouldered part of the indurated sort.

a. Black.

Is like foot. It is found at Westerfilterberg in Kopparbergslän in Sweden among the earth that covers the white iron ore.

b. Dark brown.

This somewhat resembles umbre, and is found at Solfkiensberg in Norberg in the province of Westmanland.

S E C T. 38. (32.)

B. Indurated, Indurata.

1. Solid, of no distinct particles, *Solida particulis impalpabilibus.*

a. Red, Minera ferri calcarea rubra.

Looks like red ochre, or the red hæmatites, but dissolves in the acid of nitre with a great effervescence. It is found at Hellefors in the province of Westmanland, and at Grasberg in Grangierde in the province of Dalarne.

S E C T.

S E C T. 39. (33.)

2. Scaly, *Particulis micaceis*.
 - a. White, from Nassau Siegen, and Wester-silverberget in the province of Westman-land.
 - b. Blackish grey, in Smalkalden, and the old mines at Helleforffen in Westmanland [o].
3. Spar like, *Spatosa*.
 - a. Light brown, from Nassausiegen and Smalkald.
4. Drusen, *Drusica*.
 - a. Blackish brown from Smalkalden.
 - b. White.
1. Porous. This is often called eisenblute, or flos ferri. It is found at Westerfilfverberg.
2. Cellular, from Westerfilfverberg [p].

[o] In England in the forest of Dean, where it is called grey ore, and at Bigrig Moor in Cumberland.

[p] These kinds, in regard to their texture, are so like those calcareous stones we call *limestones* (§ 9), and spars (§ 10 and 11), that they may be easily confounded with one another, were not the other characters observed at the same time. *The Author.*

S E C T.

S E C T. 40. (34.)

2. Calcareous earth united with copper, *Terra calcarea croco, seu calce veneris intrinsecè mixta.*

A. Loose and friable, *Pulverulenta five friabilis.* Mountain blue, *Cæruleum montanum*, Germanicè, *Bergblau.*

This dissolves in aqua fortis with effervescence.

S E C T. 41. (35.)

B. Indurated *indurata.*

1. Pure calcareous earth mixed with calx of copper. Armenian stone, *Lapis Armenus* [q].

[q] M. Marggraf and other chymists have proved that *lapis lazuli* contains no copper at all. It is sometimes melted on account of the silver it contains. The particles of marcasite in it indicate some martial or irony parts, and the blue colour, together with its standing the fire, depends upon the metallic parts. The Hungarian gang-works in the new mine of *St. Antonio di Padua* near Hoderitch, are sometimes full of fine blue specks, which indicate that there is a good deal of silver in it. The stone itself is certainly a compounded one; it is generally calcareous, and sometimes particles of quartz are mixed in it. *Brun.*

Such

Such according to the description of authors ought the nature of the stone called *Lapis Armenus* to be, though the druggists substitute in its stead a pale blue *Lapis Lazuli* free from Marcasite.

S E C T. 42. (36.)

2. Gypseous earth united with calx of copper, *Terra gypsea venere mixta*. Is of a green colour, and might perhaps be called Turquoise ore, or Malachites; though I do not know if all sorts of Turquoise ore are of this nature.
- a. Semi-transparent, is found at Ardal in Norway [r].

S E C T. 43. (37.)

3. Calcareous earth united with the calx of lead, *Terra calcarea cerussa nativa intime mixta*.

[r] By chemistry we know, that alkaline salts produce a blue colour with copper which is changed into green, as soon as any acid is added; and from thence the reason is obvious, why a green colour may be found among calcareous copper ores, viz. when the vitriolic acid is in the neighbourhood of it. *The Author*.

This

This is a lead ochre, or a spar-like lead ore, which in its formation has been mixed with a calcareous earth, and for that reason effervesces with acids.

A. Loose and friable, *Friabilis*.

a. White from Kristiersberget in Nya Kopparberget parish in Westmanland.

S E C T. 44. (38.)

B. Indurated.

i. Scaly.

a. Yellowish from Kristersberget [*s*].

S E C T. 45. (39.)

Observations on the calcareous Earths in general.

The calcareous earth is distributed over the whole world in proportion to its great utility, though it is sometimes absorbed and concealed

[*s*] Both these varieties contain a considerable quantity of lead, viz. forty per cent. more or less, and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore (§ 36). Thus may these be distinguished from other lead ochres and spar-like lead ores, which are much richer in lead, and never effervesce with acids. These last mentioned also seem to be produced by nature, nearly as the spar-like lead ores, and as the *flores saturni* are formed in calcining a regule of lead. *Author.*

in

in heterogeneous substances. If it could be proved that nature, to perform its works, does not require more than those two active agents, the acid and the alkali, and that the calcareous earth might under certain circumstances be changed into a mineral alkali as some have conjectured; the necessity of the existence of the calcareous earth would be sufficiently obvious. But I pass over all these hypotheses; since they will perhaps, remain for ever undecided. It is certainly of more consequence to attend to the advantages which are to be derived from it in human œconomy, since it is more or less employed in most trades. However, I do not intend to enter into all those particulars, but only to mention how the calcareous earth, when in its crude state, is commonly made use of.

When in the form of a loose earth, it is used for white-washing. It is mixed to advantage with clay in agriculture: for, according to Dr. Kullbell's rules of vegetation, its alkaline quality serves to unite fat substances with water: besides that it is of a drying nature, and renders the clay less coherent, or, as the farmers say, "makes the plowing easier." Hence this loose earth, in some foreign countries, is called marle; for, when added to clay, it promotes vegetation like marle. The *humus conchacea*, or shelly sea-sand, is looked upon as pretty nearly of the same quality; but it is unfortunate that clay for the most part is scarce in those places, where the calcareous earth is found in plenty, and that sometimes more is expected from this last than
it

it possibly can perform. This loose or friable calcareous earth may easily be made into lime, if it be previously slacked with water, and made up in moulds.

The indurated calcareous earth, or lime in masses or lumps, are very useful in arable land, because it moulders by degrees on the surface, and attracting the water, retains it longer than most other kinds of stones. The arable lands in the province of Jemtland, at Rettwick in Dalarne, at Kinnekulle in Westergottland, and in other places, which consist merely of a calcareous earth, or a mouldered slate, would suffer a great deal from the sun in dry seasons, if they were not covered with lumps of limestone.

The art of building cannot be pursued without the use of limestone; and in this business alone it is known, and made use of under different names.

The solid limestone commonly found in Sweden, is mostly slaty, and when it is of such indifferent colours as not to deserve polishing, is called in Swedish Telgstén, Alfvarsten, and Oelandsten, in English simply limestones. The thickest strata are always employed in large works, to which purpose they are very well adapted; and the thinner are cut into square slabs to pave the floors, and for the stairs of houses, and other æconomical uses. But great care must be taken in the choice of these stones, since it may happen that the finer works, made of this kind of stone, will in length of time, crack and break into two or more plates, especially

cially if they are exposed to the open air, because this stone is for the most part set with small partition veins of indurated marle, which moulders in the air. And this is the reason why the uppermost strata, in those quarries, are always rejected, and regarded as a different kind of stone. It is, by the Swedish workmen particularly, called *Gorsten*, in English *Rubble-stone*.

When the limestone is of brighter colours, though sometimes no more than only of a dark brown, it receives the pompous name of *Marble*: and for such works as are to be polished, the pieces are always chosen out of the thick and solid strata, which lie so deep under-ground, that they have not been spoiled by weathering or decaying. This stone is likewise the most proper for that purpose, in preference to all other limestones, because it is perfectly opaque, and reflects the light from the surface. Most of the Italian and antique marbles are of this kind, for instance:

Marmo nero di Fiandra—The black marble of Flanders.

Marmo giallo di Siena—Plain yellow.

Marmo giallo antico—Yellow, with some white veins.

Marmo di fiume d'Arno—Yellow, with black dendrites.

Marmo di Firenze, Paesino—Yellow, with brown figures, resembling ruins.

Marmo nero e giallo di Porto Venere—Black and yellow.

Marmo nero et bianco di Carrara—Black and white.

Marmo tartufato d'Urbino—Pale yellow, with spots of a blackish grey colour.

Marmo brocatello di Spagna—Yellow, white and red.

Marmo palombino antico—Pale yellow.

Marmo alberino di monte Gallicano—Olive colour with deeper coloured cross lines, and dendrites.

Marmo rosso di San-Giusto—Brownish red.

Marmo carnagione de Pistoia—Flesh coloured and yellow.

Marmo rosso di Monsummano—Common red marble.

Marmo fior di Persico di Saravezza—Crimson, white and grey.

Marmo pavonazzo—Reddish-brown lumps on a whitish ground.

Marmo bardiglio—Bluish-grey.

Marmo statuario di carrara----Of a snowy white.

With infinitely more varieties, whose number is improperly augmented by those who for interest sake collect specimens, and likewise by some virtuosos, who pay too much regard to colours and figures. From the above we find, that the Italian names are for the most part taken from the colours. When they have a marble from an unknown place, they call it *antico*. Every one that has a number of bright colours, is called *brocatello* or *broccatellato*. The figures are chiefly regarded in the *Paesino di Firenze*,

Firenza, Alberino di monte Gallicano, &c. &c. When some of the originals are wanted to compleat the whole set of marbles, they are substituted either by others, that have the most resemblance to them, or by white marbles stained or coloured; and this is the case with the *marmo di sangue di dragone*. To this species of solid limestone also belongs the marble from Blankenburg which is red, black, and white; likewise that from the province of Jemtland in Sweden, which is black, and white, or only black; and the French marbles, viz. *Serfontaine, Antin, Seracolin, St. Baume, Servelat, &c. &c.* which have several bright colours. The finest solid modern marbles are those from Italy, Blankenburg, France and Flanders. There are also marbles dug in Saxony, and other parts of Germany, in Norway, and Sweden; but either they are not of such agreeable or striking colours, or else are of that species which is called the scaly glittering limestone, mentioned in Sect. 9.

There are, however, several among the above-mentioned marbles which are partly mixed with the scaly limestones (Sect. 9.) though not in such a quantity as to constitute the principal part of the stone, but only as a substance which has joined together lumps of the solid limestone, or else filled up its empty crevices or cracks. This kind, however, ought not to be rejected, but might be used as a marble, if only such pieces were chosen that have the finest texture: because those with coarse scales, when polished,

are of an icy appearance, as the masons term it, and do not show their true colours, by reason of the semi-transparency of their particles, and their different positions in regard to one another, as may be seen in the marble from the parish of Perno in Finland.

Of the fine glittering limestone (§ 9. n. 3.) are the following :

Marmo bianco di Carrara, the white marble, the *Saligno*, the *Parian*, the white Italian marble, which, however, is never polished when made use of but only finely ground down ; the *Bigio antico*, *Porta Santa*, *Carnagione di Verona*, et di *Siena*, *Tigrato antico*, *Rosso antico*, *Giallo antico in oro*, *fiorito*, et *Giallo abbruciato* ; every one of which is somewhat transparent at the edges.

In the parish of Pargos, near Abo in Finland, is found a white marble, which, to judge from the samples I have seen, gives room to hope that it is as good as the Italian, when they have got beneath the first stratum.

But the other Swedish white limestones, for instance that from Lillkirke and other places, are either of too coarse a texture, or so intermixed with semi-transparent particles as to give them, at a distance, a very disagreeable appearance as if they were dirty.

The ancient statuary marble is likewise very transparent : but as this transparency is equally diffused through all parts of the stone, it does no harm, but makes it look rather like alabaster.

While we are on the subject of marbles, it is necessary to observe, that as the Italians have a well-

well-founded right of giving names to the different varieties of marbles, and of furnishing us with samples, both of such as are found in their country, and of foreign ones which in former ages have been employed there, and now are called *antichi*; it is in regard to those collections, or *studi*, that most stones which take a polish have been called marble, although the Italian mason himself knows extremely well how to distinguish a marble, a jasper, and a granite, from one another, giving the two last names only to marbles of such colours as these species generally have, when he either cannot get any real ones of those harder stones, or will not give himself the trouble to polish them. This confusion in the names may, however, in regard to this system, be tolerated, since these three different species of stones, viz. the limestones, the jaspers, and the granites, are here separately described: but since they cannot all be worked in a like manner, nor do they equally resist the violence of time, they deserve to be known by the architects in a clearer manner, and by separate names.

A yet less confusion is that of the *Saxum*, which, though compounded of limestone and serpentine, is called marble, not only when it contains a greater quantity of the limestone, as the marble from Kolmorden in the province of Ostrogottland, but also when the serpentine predominates, as in the marble called *pozzevera di Genova*, and also a kind of green marble from Spain, because this kind of stone is as easy to

cut and work as a true marble, although the serpentine is somewhat softer, and easier to polish.

The calcareous spar (§ 10), and its crystallisations (§ 11), are more difficult to be burnt into lime, than other limestones. They are also of no great use in architecture, any further than that they may be employed in making *grottos*. Nature seems to have made the quantity of this kind proportionable to its use. But

Gypsum or plaster stone is of very great consequence in building; and its strata, which are very sparingly distributed in the earth, are worth searching for. If it be true, that the strata of the earth are situated in a regular order throughout the whole globe, as some assert, and concerning which they have formed systems to themselves, founded upon observations made only at some few places, we might expect to have a considerable quantity of this stone; but there are innumerable experiments yet wanted, before this can be demonstrated. In the mean while, it may be asked, and with some reason, whether the gypsum ought to be searched for in any other place besides those strata where there is a positive proof of their having been formed in the middle age, by means of water carrying their particles with it, and depositing them as a sediment there, and where also the vitriolic acid has been present? likewise, whether these strata ought before to have been set on fire, whereby the vitriolic acid already contained in them has been separated from the inflammable

flammable substance, by the action of fire, and afterwards fixed itself in the pure calcareous earth?

The miners use crude limestone to make the hearths of their iron furnaces, and as fluxes in melting their ores. The solid and the scaly limestones are both employed to the former use; but the scaly (§ 9.) is the best, and next to that the grained limestone (§ 8.)

Those who intend to search for limestone to make lime, and are afraid to mistake the white iron ore (§ 36.) for it, ought only to observe, that the latter always decays in the open air into a black or blackish brown powder, and becomes also of the same colour in the fire. However, when this iron ore contains only a very small quantity of iron, it may be used to make lime; though it becomes of a grey colour, just as when clay is mixed with limestone, as in the *alfwarsten*, in which there is always some mixture of clay.

It seems as if the white iron ore might be used with advantage, and preferably to others, in making cement, whose constituent parts are always lime and iron; but it is neither apt to concrete, when once mouldered; nor, by experiments made for that purpose, has it discovered any quality of binding or uniting. We must therefore examine other substances, which may better answer the intention; and then it will be found, that iron, which is too much in its metallic state, is easily affected by the vitriolic acid, for which reason the cement containing

it must in length of time be dissolved and rendered useless, and likewise on the contrary, that a perfectly calcined iron is not of so much service as when it has some of its phlogiston left. For instance, a cement prepared from the slags of a smith's forge, mixed with lime and coarse sand, has been found, in some respect to answer all the good effects expected, it depending only on time to shew, whether it possesses the requisite durability. The *terra puzzolana* or *terras* is a sandy marle mixed with iron and baked in a strong fire. Its effects, however, in the cement, may, perhaps, depend only on the iron which has been reduced into a particular substance by means of subterraneous fires, evident signs of which are observable in the places where it is obtained.

If the slate in Henneberg, or Kinnekulle in the province of Westergottland should happen to get fire, the uppermost stratum, which now consists of a mixture of iron and different kinds of rocks, called *graberg* in the account given of them, they might perhaps be changed partly into slag and partly into *terra puzzolana*.

S E C T. 46. (Additional.)

THE foregoing Sections were already printed off, when the work of that excellent philosopher and able chemist Mr. Kirwan, whom I enjoy the happiness of calling my friend, made its appearance to the public, under the title of *Elements of Mineralogy*; I therefore take the advantage of extracting from it some new observations which could not enter into their respective places, to illustrate the subject of calcareous earths.

Among the simple earths the calcareous alone (though perhaps the ponderous may have the same property, when proper experiments come to be made on it) can be looked upon, as the menstruum of other earths; for according to the important discovery of Mr. D'Arcet, they are all rendered fusible by a proper proportion of this earth, though infusible by themselves. *Calcareous* earth requires for its fusion half its weight of *magnesian*, and only one third of its own weight of *argillaceous* earths, according to Mr. Achard: and Mr. Gerhard having exposed *siliceous* earth to a violent heat in a crucible of chalk, found it vitrified in the edges, where it touched the *chalk*. Even in the *liquid way*, this earth manifests the same affinities. Thus if pure earth of alum (the *argillaceous*) be added to lime water, the lime will be precipitated

pitated as Mr. Scheele asserts: and this precipitate is soluble in marine acid, which shews that it does not arise from any remainder of the vitriolic acid, as selenite is not soluble in the marine acid.

The affinity of calcareous earth to other earths, according to Mr. Kirwan, stands thus, 1st, the calx of iron: 2dly, the argillaceous: 3dly, the magnesian: and 4thly, the siliceous earth.

When calcareous earth has acted as a menstruum upon another earth, a compound arises, which acts more powerfully on other earths. Thus, though one hundred parts of *lime* can dissolve or liquify very little of the *siliceous* earth, yet when it has taken up fifty of *magnesia*, they may dissolve one hundred of the *siliceous*: and this last compound becomes still more powerful; for equal parts of *lime*, *magnesia*, and *sillex* form a perfect glass: hence equal parts of each simple earth will vitrify in sufficient heat, provided the *calcareous* be one of them: nay equal parts of *lime* and *argill*, will melt 2 or $2\frac{1}{2}$ of *sillex*: and other mixtures will be more or less fusible, as they approach to this proportion.

“ Calcareous earth when pure has a hot burning taste, acts powerfully on animal substances: and when in lumps heats by the addition of a moderate quantity of water.”

“ In the temperature of 60° (of Fahrenheit's thermometer) it requires about 680 times its weight of water to dissolve it. Its taste is then pungent, and urinous, yet sweetish.”

“ When

“ When in vessels, on which it cannot act, it is infusible *per se* (singly), in a heat that would melt iron : yet it assumed a slight beginning of fusion when exposed, on a piece of charcoal, to the focus of the solar rays of the admirable burning lens lately made by Mr. Parker. But when mixed with other earths it easily melts : from whence it appears, why it melts when put on porcelain, or other earthen vessels.”

“ It is hardly affected by fixed alkalis ; but it easily melts, without effervescence, if pure, by *borax*, *microscopic salt*, or *calces of lead*.”

Addition to note u § 5. The *Calx Bathensis* already mentioned is a stone of a grey colour, moderately hard, or rather soft, found near Bath ; composed of *calcareous* earth, partly *pure*, and partly *combined* with *aerial acid* : the first is evident by it being soluble in water, to which it communicates the taste of lime : and the second, by its effervescence with any *other acid* stronger than the *aerial one*, as mentioned note *g* to § 4. These stones become harder when exposed to the air some considerable time ; because they attract the sufficient quantity of *aerial acid* to be saturated : and many other stones, which have the same property, seem to be in a similar case [*t*].

Mr.

[*t*] This seems to be the chief circumstance, to which the cement and mortar of the antients, owns its amazing hardness, as observed in many of the Roman buildings still remaining

Mr. Monet found also this earth in a loose, dry and powdery state, in the mountains of Auvergne; which he suspected to proceed from some volcanic operation.

Addition to § 10. Calcareous spars are of a lamellar texture, and mostly break or split into rhomboidal plates or laminæ: their crystallized forms are various, as rhomboidal, hexangular, triangular, polyangular, but the first is the more common. Their specific gravity is generally about 2700, when pure from metallic particles. They generally contain from 34 to 36 per cent. of *aerial acid*, 53 to 55 of mere earth, and the remainder of water. When pure they are colourless: but the mixture of metallic particles renders the green, or brown, reddish, yellowish, and even black colours that some have.

Addition to note i § 12. The *Stalagmites* do not differ from the *Stalactites*, but in being formed at the bottom of caverns and vaults, whilst the last are suspended from the top of similar places, where water impregnated with calcareous particles is dropping down: and of course the first get a mammillary form, whilst the *stalactites* acquire a conic figure: the *oolithes* and *pisolites* belong to the same species. Most of these stones contain a slight mixture of argill

maining to our days. From thence it appears, that lime ought to be employed soon after being burned, in making mortar: and that it is wrong to leave this last a long while exposed to the air, as I have seen in many places, before it is employed in building. *The Editor.*

and

and calx of iron: from which they are of a grey, yellow, or blackish colour.

The *Tophi*, *Pori*, or *Duckstein* of the Germans differ from the preceding not only in shape, but principally in this, that they have been formed by a gradual deposition of earths, chiefly of the calcareous kind, barely diffused through water, made within the water itself and not in the air. Hence they are of the same colour as the foregoing. These are generally found on branches and roots of trees and stones of different kinds. Those found on the roots of pines called *osteo-colla*, examined by Mr. Margraaf, consist of calcareous earth, mixed with some siliceous earth, and volatile alkaly, together with some vegetable parts.

Addition to § 6. *Chalk*, *Craie de Champaigne*, *blanc d'Espagne* of the French, the purest is white, and yet it contains about two per cent. of argill. There is a *blue chalk* in the neighbourhood of Upsal which contains iron. Dry chalk contains more aerial acid, than any other of the calcareous kind; generally about forty per cent. Its specific gravity is from 2400 to 2650.

Addition to § 45. The *Albarese* of the Italians, and the *St. Stephen's* stones, so called on account of some red spots they have, are but lime stones: all contain some small portion of argill, quartz, and iron. Lime stones contain sometimes a small portion of magnesia and sea-salt: and some found in *Scania*, contain orpiment, according to Mr. Scheffer. Lime stones have in
general

general a specific gravity from 2650 to 2700. That of *Portland stone* is 2533: and that of *Purbeck stone* 2680, this last affords more lime, according to Mr. Watson's observation. The *Bath stone* has a more granular and open texture than the *Portland stone*: its specific gravity is 2494.

The *calcareous flag-stone*, or *Schistus* near Woodstock, is of a yellowish white colour, moderately hard: its specific gravity is 2585, it contains a little iron.

The specific gravity of marble is from 2700 to 2800: that of Carrara is 2717.

Black marble owes its colour to a slight mixture of iron. Mr. Bayen found some which contained five per cent. of iron: yet the lime made of it was white, but in time it acquired an ochry or reddish yellow colour.

Calcareous stones which grow black or brown, are suspected by *Bergman*, to contain manganese, and in this case the lime thus afforded must form an excellent cement. According to *Rinman*, white calcareous stones which grow black by calcination, contain about ten per cent. of iron.

Grey marble receives its colour from iron, which is about two per centum in it.

Blue and green marbles derive their colour from a mixture of shorl, according to *Rinman*.

Addition to § 13. The specific gravity of gypsum is generally 2320: sometimes only 1870.

Addition to § 26. Blue fluors derive their colour mostly from iron, but sometimes from cobalt.

cobalt. If iron is precipitated from the sparry acid by lime water, the precipitate is white with blue specks.

Green fluors owe also their colour to iron.

The phosphorescent property of fluors seems to arise not from the acid singly, otherwise all fluors would possess it; but from the acid, in-contact with metallic particles; viz. from the acid and phlogiston.

Addition to § 27. The specific gravity of the Tungsten is from 4990 to 5800. It is insoluble in acids, except by peculiar management. When powdered and digested with *nitrous*, or *marine* acid, it assumes a yellow colour, as was observed by Mr. Woulfe. When heated it bursts, becomes reddish, and melts very difficultly per se. It contains about half its weight of calcareous earth, and the remainder is a peculiar acid of an earthy appearance, and iron.

The *red or flesh-coloured Tungsten* spoken of by the author in this § 27, does not effervesce with acids: scarcely gives any fire with the steel: is of a coarse texture, and is easily pulverised. Its specific gravity is from 4900 to 5800. It becomes magnetic after calcination: is easily melted with its own weight of fluor: and with great difficulty affords about thirty per cent, of iron. Hence it is never used as an iron ore.

Addition to note b § 27. However the acid of tungsten has so different properties from those of the acid of Molybdene, that it must be considered as a particular acid *sui generis*: as will be seen hereafter, on treating of Acids.

SECT.

S E C T. 47. (Additional.)

Many compounds of calcareous earth with different mineral substances deserve to be noticed in this place, which Mr. Kirwan mentions in the valuable Treatise that has afforded the materials for the foregoing Section.

1. A compound of *calcareous* and *barotical* earths: of this species are some yellowish stones found in *Derbyshire*, consisting of lumps of *limestone* interspersed with nodules of *baroselenite* of § 49. Many more may occur as compounds of *gypsum* and *baroselenite*, *fluor* and *baroselenite*, &c. &c.

2. Compounds of *calcareous* and *magnesian* earths, such as

a. The white marble interspersed with spots of *steatites* or *soap rock*, either *green* or *black*, called by the Author *kolmord' marble* in his § 261. This marble is of a scaly texture.

b. The *pietra talchina* of the Italians, which consists of *white spar*, with veins of *talc*.

c. The *verde antico* of the Italians, which is a *light green marble*, with *deep green*, *black*, *white*, and *purple* spots. According to Mr. Bayen it contains sixty-two parts of *mild calcareous earth*, thirty of *green talk*, one of *magnesia*, and one of *semipblogisticated iron*.

3. Compounds

3. Compounds of *calcareous* and *argillaceous earths*. Such as

a. The *green Campan marble* from the Pyrenées. It is slaty and somewhat magnetic. According to Mr. Bayen it contains 65 of mild *calcareous earth*, 32 of the *argillaceous*, and 3 of *semiphlogisticated iron*.

N. B. Mr. Kirwan observes, that this *shistus* must have at least 10 parts of iron to be magnetic: and that this iron is not much dephlogisticated, as indicated by the *green* or *blue colour*, which when it proceeds from iron, always denotes that it is not much dephlogisticated: whereas on the contrary, the *red* or *yellow colour*, denotes its being *dephlogisticated*.

b. The *red Campan marble*: this is not magnetic: it contains 82 parts of *mild calcareous earth*, 11 of *argillaceous shistus*, and 7 of *dephlogisticated iron*.

c. *Yellow figured marble* from Florence: according to Mr. Bayen, it contains 75 parts of *mild calcareous earth*, 13 or 14 of *shistus*, and 4 or 5 of *dephlogisticated iron*.

d. *Griotte marble* from Autun of Burgundy in France: it contains 67 parts of *mild calcareous earth*, 26 of *redish shistus*, 2 of *iron*, and 1 of *magnesian earth*.

e. The *Amandola*, which is a green marble, honey-comb like with *white spots*. It contains 76 parts of *mild calcareous earth*, 20 of *shistus*, and 2 of *semiphlogisticated iron*. The cellular appearance proceeds from the *shistus*.

4. Compounds of *calcareous earth* and *mica*, such as
 - a. The *Cipolin* from Autun in France: it is of a green colour, and consists of 83 parts of *chalk*, 12 of green *mica*, and 1 of *iron*.
 - b. The *micaceous limestone*, is of a glittering appearance, of various degrees of hardness, and effervesces with acids. Such as the *macigno* of the Italians: their yellow *pietra bigia*, and their blue *pietra columbina*, or *turkina*.
5. Compounds of *calcareous* and *siliceous earths*, such as
 - a. The *calcareous quartz* and *pudding stone*: this consists of lumps of *quartz* and sometimes of *felt-spar*, in a *calcareous cement*.
 - b. The *limestone* with veins of *quartz*, such as The *Saxum Sahlbergense*, and several marbles of *Sweden* and *Siberia*, which strike fire with steel.
6. *Calcareous volcanic pudding stone*, such as
 - a. The *cierchina*, which consists of lumps of *spar* and *lava*, in a *calcareous cement*, mentioned by Mr. Ferber.
 - b. The *marble* mixed with veins of *black* or *green lava* mentioned by the same Author.
7. Compounds of *calcareous earth*, mixed with two or more kinds of earth: such as
 - a. The *cipolin* from Rome, which is a green marble, with white zones: it strikes though difficultly, fire with steel: it contains 67, 8 parts of mild *chalk*, .25 of *quartz*, 8 of *shistus*, and 0, 2 of *iron*, besides the *iron* contained in the *argillaceous shistus*.
 - b. The

- b. The *calcareous porphyry*, which consists of *quartz*, *felt spar*, and *mica* in separate grains, united by a *calcareous cement*.
- c. The *limestone* interspersed with *shoerl*, and *mica*.
- d. To these compounds belongs the *pyriteous limestone*, called by the French *Pierre de St. Ambroix*. It is of an iron-grey colour, interspersed with shining particles. Its texture is compact, and scarcely gives fire with steel. Its specific gravity is 2,7034.

It is soluble in acids, and mostly with effervescence: calcines in a strong fire: makes nitre slightly detonate: and if distilled, affords a small portion of vitriolic acid, and some sulphur sublimes.

Its component parts are 75 of mild *calcareous earth*, and 25 of *pyrites*, in which are contained 14 of *argill*, 7 of *quartz* and *sulphur*, and 4 of *iron*.

ORDER THE SECOND,

PONDEROUS EARTHS.

S E C T. 48. (Additional.)

PONDEROUS earth. *Cauk*, or *calk*. *Lat.* Terra ponderosa. *Sw.* Tung-spat, spathig-gyps. *Fr.* Terra pesante, barote. *Germ.* Späthartiger gyps.

This is a particular kind of earth, like chalk in appearance, but with some very different properties, lately discovered in Sweden (about 1774), which by its results with other bodies has some similarity to the known alkalis. It has not yet been found pure, but mixed with other substances: however, its great specific weight easily distinguishes it from the others, it being the heaviest of all earths.

1. Its specific gravity when considerably purified by art [*u*] is 3,773.

2. This earth combines with aerial acid: and in this case effervesces with stronger acids.

3. With vitriolic acid it forms the ponderous spar of Sect. 50, which is insoluble in water.

4. Its crystallisation after being combined with the nitrous, or with the muriatic acids, is hardly soluble;

5. But with acetic acid, it becomes deliquescent [*v*].

6. When pure; viz. without any mixture of acid or alkali, it does not vitrify in the fire.

[*u*] To have this earth as pure as possible, let the *ponderous spar* (sect. 51.) or the *marmor metallicum* (sect. 50.) be reduced into powder: and be burnt for one hour in a crucible, with equal parts of fixed alkali and charcoal: then reduce it into powder again: add to it nitrous, or diluted muriatic acid, till the effervescence is over, so that the acid may prevail: throw into it mild fixed alkali: and the ponderous earth will be precipitated. In a hundred parts by weight of this earth so purified, are contained twenty-eight parts of *water*, seven of *aerial acid*, and sixty-five, of *ponderous earth*. It seems to contain some *metallic acid*, as yet unknown, similar to the acid of Molybdene, except that its combination with *lime-water* is very different from this last. *Berg. Sc.* §. 33 and 88.

[*v*] The crystallisations of calcareous earth have the contrary properties, being *deliquescent* when formed from the combination with nitrous or with muriatic acids: and *not deliquescent*, when formed by the acid of vinegar. *Berg.*

7. If deprived of the *aerial acid* (*fixed air*) by calcination, is then soluble in 900 times its weight of boiling water. This solution exposed to air, forms a *cremor*, like that of lime-water in the same circumstances, and like it changes also the vegetable colours.

8. Whilst combined with *aerial acid*, it is only soluble in about 1550 times its weight of water [*w*] chiefly if the water has been impregnated also with the same aerial acid.

9. It expels the caustic volatil alkali from ammoniacal salt.

10. Mixed with brimstone it produces a *hepar sulphuris*, whose solution in water is but incompletely decomposed either by the nitrous or the muriatic acid, on account of the great attraction between this earth and the acid of sulphur, which is so strong that it

11. Separates this acid (the vitriolic) from the vegetable alkali [*x*].

[*w*] On the contrary, calcareous earth, when pure, is more soluble in water, than when combined with aerial acid. *Berg.*

[*x*] Ponderous earth takes up the vitriolic acid, when combined with calcareous earth: but this last earth takes the acid of sugar from its combination with ponderous earth. See *Morveau's Mem.* in *Journ. de Physique* for *March 1783.* *The Ed.*

Doctor Withering found that caustic alkali precipitates this earth from the *nitrous* and *marine acids*, which happens, it seems, from their taking up the excess of acid required to keep it in solution. *The Editor from Kirwan.*

S E C T. 49. (Additional.)

Ponderous earth combined with aerial acid.
Terra ponderosa aërata.

It resembles alum, but is hard and striated, as if composed of radiating fibres coming from a center. It is found in Alston-moor in England [y].

Its specific gravity is 4,338.

Dr. Withering found that this substance does not burn to lime, as it melts rather than parts with its aerial acid [z].

[y] Dr. William Withering of Birmingham made the analysis of this substance which he communicated to the Royal Society of London: he was the first who discovered this earth by examining native specimens found in England. It is highly probable that many different combinations of this new kind of earth will be found mixed with other earths, when mineralogists pay a proper attention to examine mineral subjects by a chemical analysis with greater accuracy, than they have hitherto done, as Bergman remarks in § 91 of his *Sciagraphia*. *The Edit.*

[z] It contains 20.8 parts of *aerial acid*, 78.6 of *ponderous earth* and the remaining 6 consist of the *vitriolic baro-selenite*, without any water. The artificial barote has very different component parts, as mentioned in § 48. *Withering.*

S E C T. 50. (18.)

Spar-like gypsum. *Lat.* Marmor metallicum. Lapis Bononienfis. Phosphorus natus. *Sw.* Tarninge-spath. *Fr.* Baro-selenite, Spat seleniteux, gypse phosphorique. *Germ.* Wurf-fel-spath.

This stone, on account of its specific gravity which comes near to that of tin or iron, is suspected to contain something metallic, but as far as is hitherto known, no one has yet been able to extract any metal from it except some traces of iron, which is no more than all other gypsa contain.

A. Semitransparent, *spatum Bononiense*. The Bononian stone or phosphorus [a].

Its

[a] Mr. Margraff has published some curious experiments in the Memoirs of the Academy at Berlin, about the quality these spars have to yield phosphorus; and has shewn, that every gypseous earth is fit for it, provided metallic particles are not predominant in it: now, as the Bononian spar, which is ponderous, is of this species, and is the most fit to be brought to a phosphorus, it is evident, that no metallic mixture is the cause of its weight.

Mr. Scheffer, in the Memoirs of the Academy at Stockholm, for the year 1753, has communicated some experiments upon a stone of this kind from China, which prove that it perfectly agrees with the descriptions given in several books, of a stone called *petuntse* by the Chinese, and which, it is said, is used in their China-manufactories. The phosphorus of Baldwin illustrates Mr. Margraff's experiments. The phosphorescent quality

Its specific gravity is 4,500.

B. Opaque: *a.* white: *b.* Reddish: are found in Wildeman at Hartz, and in other German mines [*b*].

S E C T. 51. (19.)

C. Ponderous Drusen spar. *Lat.* Marmor metallicum Drusicum [*c*].

1. Jagged or like cock's combs. *Cristatum.*
These

quality of these stones is, however, different from that of the sparry limestones and fluors, which is only produced by their being slowly heated, and seems to arise from a phlogiston, which is destroyed in a glowing heat. *The Author.*

It does not burn to plaster of paris, as gypsum does: is infusible *per se*: it is often mixed with calcareous earth: and sometimes accompanies the ores of metals: it forms likewise the basis of some petrifications. It contains 84 parts of *ponderous earth*, 13 of the *most concentrated vitriolic acid*, and 3 of *water*: but the artificial baroselenite contains 33 parts of *vitriolic acid*, and 67 of *ponderous earth*.

Mr. Morveau decomposes this substance by a very easy method: viz. by calcining it with one sixth part of its weight of *charcoal*, for one hour in a crucible, well luted, in a strong red heat: and finally dissolving it in the *acetous acid*. The sulphur is thus separated.

[*b*] The red spar, or baro-selenite, and sometimes the other varieties contain 1 or 2 parts of iron in one hundred. *Kirwan.*

[*c*] Regularly Crystallised aluminiforme, solid, and semi-transparent. This species is found in the lead mines of Alston-moor on the county of Cumberland in England. Mr. William Thomson, of Christ-church-college at Oxford, a young

These resemble cock's combs, and are found in clefts and fissures accreted on the surfaces of balls of the same substance [d].

young gentleman intimately acquainted with mineralogy, shewed me some fine specimens of this mineral, and very properly remarked that it seems to affect the peculiarity of having its crystals laminated, as radiating from a center: but this radiation seldom amounts to a whole circle. The corners of these flat crystals are truncated, like those of alum, and are thicker in one side than in the other of each parallelogram, so as to fit one another in the arch of the kind of vault they form together: and have some small ones adhering to their sides, like *drusen spars* leaving internal angles, as the *macles* of the French, or the cruciform crystallisations.

The specific gravity of the fine ponderous crystals, being examined by my worthy friend Mr. Nicholson, with an instrument of his own invention well calculated for the easy and exact finding of specific gravities, was found from a piece of this spar, regularly crystallized and mostly transparent, to be with respect to distilled water, at the temperature 60° fahrenheit, = 44745 : 10000. Dr. W. Withering, the learned translator of Bergman's *Sciagraphia* into English, wrote to me not long ago, that he had discovered some curious properties in the *spatum ponderosum*, which he intended to communicate soon to the Royal Society of London. *The Edit.*

This species is found also in Auvergne in France, and has been described by Mr. Bayen, who believed its basis to be calcareous. The surface of its crystals was covered with ferrugineous ochre. It was extremely refractory. *Fabroni.*

[d] This species is found also in Derbyshire, where it is called *cauk*, or *calk*. My worthy friend Mr. J. Whitehurst, F. R. S. shewed me various specimens of this mineral, not only with convex, but with flat surfaces: the upper surfaces of the aggregated parts appear rather like the edges of very thin flat-tish lenses put together, than edges of cock's combs. *Edit.*

2. White,

2. White, from Hartz and Kongberg in Norway.
3. Reddish from Wildeman mine in the Hartz [e].

S E C T. 52. (24.)

Ponderous earth united with phlogiston and the vitriolic acid, *Terra ponderosa phlogisto et acido vitriolico mixta*. *Leberstein* of the Germans and Swedes. *Lapis hepaticus*.

This stone in some specimens constantly, but in others only when rubbed, smells like the *hepar sulphuris*, or gun-powder. It excites no effervescence with acids, and is a medium between the gypsum and the foetid stones of Section 29, with which it has, however, generally been classed, although no lime can be made from it; whereas they are the fittest of all the different lime-stones to be burnt into lime.

It is found. /

A. Scaly.

1. With coarse scales.

[e] 4. Fibrous, in the form of zeolite or asbestos in filaments. Mr. Monet has observed that these spars frequently contain phlogiston, for they become a liver of sulphur in a strong heat without addition. But Mr. Woulfe never found any, and thinks Mr. Monet was deceived by charcoal falling into his crucible. *Phil. Transf.* 1779, p. 15. *Fabroni*.

a, Whitish

- a. Whitish yellow, from Stollen at the mine called Gotteshulffe in der Noth at Kongfberg in Norway.
2. With fine glittering or sparkling scales.
- a. Black, is found in form of kernels or balls in the allum-flate at Andrarum in the province of Skone [f].

ORDER

[f] The method that nature takes in combining those matters which compose the *liver-stone*, may, perhaps, be the same, as when a limestone is laid in a heap of mundic, while it is roasting: because there the sulphur unites itself with the limestone, whereby the limestone acquires the smell of liver of sulphur, instead of which the vitriolic acid alone enters into the formation of gypsum. How the sulphur combines itself may likewise be observed in the slate balls or kernels from *Andrarum alum mines*, where it sometimes combines itself with a martial earth with which this slate abounds, and forms therewith pyrites within the very slate balls. I have called this species the liver stone, notwithstanding that name, by reason of its colour, has before perhaps been given to some other kind; but as (in my opinion) the colour is a circumstance of very little or no importance in mineralogy, so as not to deserve to be taken notice of, in preference to other characters of more consequence, I hope my boldness herein will be excused. The fœtid or swine-stones, and the liver-stone, are, in regard to the structure of their parts, subject to the same varieties as the other species of lime-stone: and it is to be observed that a volatile alcali is commonly supposed to have entered into the composition of the fœtid stones, though it has never yet been discovered by any experiment. *The Author*,

N. B. This last assertion is contradicted by Wallerius sect. 43. p. 149. who positively says, that a volatil alcali is certainly found by a chemical analysis of these stones; but

Non nostrum tantas componere lites.

According to Bergman this is a ponderous earth, combined with vitriolic acid, mixed with rock oil, and with the calcareous, argillaceous and filiceous earths. See his *Sciagraphia*, § 90.

ORDER THE THIRD, MAGNESIAN EARTHS.

SECT. 53. (Additional.)

MAGNESIA, or Magnesian earth. *Lat.* Magnesia Alba, *vel* Terra Muriatica.

This is a white, loose, and light earth, only known since the beginning of this century [g].
It

§ 90. The same chemist adds, that one of these kernels from Andrarum, gave by a chemical analysis twenty-nine parts of caustic ponderous earth; thirty-three of the siliceous: almost five of the argillaceous, and 3,7 parts of lime, besides the water and vitriolic acid, which entered in its composition.
The Edit.

The *lapis hepaticus* is generally compact, but not hard enough to strike fire: its texture is either equable, or laminar, scaly, or sparry, and it takes a polish like alabaster, does not effervesce with acids, and when calcined is partially reduced to a sort of plaster of Paris. One hundred parts of it contained, by the analysis of professor Bergman, 33 of baro-selenite, 38 of siliceous earth, 22 of alum, 7 of gypsum, and 5 of mineral oil. *Kirwan.*

[g] It was at Rome that this earth began to be known by the name of *Count de Palma's powder*, which a Regular Canon there

It is generally found combined, or mixed with other heterogeneous substances, as other simple earths are.

1. When pure [*b*] its specific gravity is 2,330, and then
2. It neither hardens, contracts nor melts by the application of heat, even by the solar rays [*i*].

3. But

there offered as a general remedy for all disorders. It was considered by many, as a kind of calcareous earth: but F. Hoffman was the first that shewed it to be essentially different: and afterwards Dr. Black of Edinburgh, as well as the famous A. S. Margraaf of Berlin, though unknown to each other, demonstrated this truth, by numerous and masterly processes.

Berg.

[*b*] To have pure magnesia, let Epsom-salt in well formed crystals, be dissolved in distilled water: and from this the magnesia is to be precipitated by mild volatil alkali. Some of this earth, that remains suspended in the solution by means of the aerial acid, may be easily precipitated by a simple ebullition. The hundred weight of this magnesia when dried, contains near 25 parts of *aerial acid* or *fixed air*: 30 of water: and 45 of pure earth. Its specific gravity then is 2,155. The fixed air and water may be totally driven off by calcination.

Bergman.

[*i*] The contrary (seemingly) appeared by the experiments made in London the last summer (1782) with the burning lens of Mr. Parker, whose effects are the strongest ever heard of, though its diameter is but 32 English inches and a half in the clear. A cubic piece of magnesia, a quarter of an inch square being put in its focus, was hardened and reduced to less than a third part on each side, (viz. from the 25 hundredth part of an inch, to 8 hundredths.) I was struck with this fact: but on applying to the same focus a similar cube of the magnesia I had received from Mr. Henry's manufacture at Manchester; this neither became harder nor sensibly diminished in its size. According to Bergman, unless this earth be precipitated by the volatil alkaly or by the neat crystallised tartar,

3. But it melts easily with borax, or microcosmic salt; though it is scarcely affected by fixed alcalis, or calces of lead.
4. Mixed with other earths, it produces by fire, different hard masses [*k*].
5. It gives no causticity, except to the volatile alkali: and
6. Does not effervesce with any acid.
7. When mixed with water it shews a very small degree of heat, but without any effervescence. And when the water exceeds the weight of magnesia about seven thousand six hundred and ninety-two times, it is totally dissolved. (*Kirwan.*)
- 8 and 9. Being put in water and afterwards dried, it contains $\frac{18}{1000}$ parts of its weight; though when saturated with aerial acid, it will absorb and retain after being dried, $\frac{66}{1000}$ parts of water.

tartar, any other alkaly brings some mixture of siliceous or calcareous earth: and nearly the same happens, when it is separated by calcination from the remaining lixiviations of the nitrous and marine acids; in which case by such a continued fire, it adheres together and even shows a tendency to vitrify. *Edit.*

[*k*] Mixed with calcareous, siliceous, and argillaceous earths, it melts in the fire: and if four times its weight of green glass, be added to it, a kind of porcelain is produced hard enough to strike fire. But neither an equal part of the above earths, or of ponderous earth, glass of lead, alkali of tartar, and vitriolated tartar added separately to magnesia will melt in the fire: however when mixed with common argillaceous earth, it melts into a hard mass. *Berg.*

10. This

10. This earth combined with aerial acid is more soluble in cold than in hot water.
11. Combined with vitriolic acid it cristallises into a bitter salt, known by the name of *Epsom* and *Seydlitz* or *Seidschütz* salt, which is soluble in little more than its own weight of water.
12. With nitrous acid it forms a deliquescent salt.
13. With the muriatic, or the acetous acids it does not crySTALLISE: and the mass being dried, attracts humidity from the air.
14. It has a stronger attraction to the fluor acid than to any other, (*Berg.*): and cristallises with it into hexangular prisms whose ends are formed of two low pyramids, of three rhombs each (*Romé de l'Isle.*)
15. It is not precipitated from other acids by the vitriolic, as calcareous earth is [1].

[1] Calcareous earth has several different properties from those of magnesia, as for instance, it does not take up more water when combined with aerial acid: it renders the fixed alkali caustic by calcination: its combination with vitriolic acid produces a selenite hardly soluble in 4 or 500 times its weight of water: with the acetous acid gives permanent crystals, &c. *Berg.*

S E C T. 54. (Additional.)

Magnesia combined with vitriolic and other acids.

A. Magnesia when saturated with the vitriolic acid, forms a bitter salt, called *English* or *Epsom*, *Seydshutz* or *Sedlitz* salt. The salts known under these different names only differ from one another on account of some heterogeneous substance, which is combined in them, the vitriolated magnesia being the characteristic and principal ingredient in them all.

B. Magnesia is found not only combined with the vitriolic acid in the waters of Epsom, Sedlitz, &c. but also with the marine acid to a considerable quantity in sea-water and other salt springs.

C. It is contained frequently in fresh waters where it is dissolved by means of a quantity of aerial acid. *Fabroni* from *Bergman*.

S E C T. 55. (79.)

Combined with other Earths [m].

A. Magnesia when combined with siliceous earth, is commonly unctuous to the touch: and more or less difficult to be cut or turned, in proportion to its different degrees of hardness.

It is not diffusible in water: grows hard, and is very refractory in the fire.

When pounded and mixed with water, it will not easily cohere into a paste: however, if it is managed with care, it may be baked in the fire to a mass, which being broken, shews a dull and porous texture.

It takes for the most part, and without much labour, a fine polish. It is found,

Compact and soft, *particulis impalpabilibus mollis*; *Smectis*, Briançon or French chalk [*n*].

a. White, from the Lands-end, in Cornwall.

[*m*] The substances treated of in this and in the several following sections have been indicated by Bergman (in his *Sciagraphia* § 107), as belonging to the *magnesian earths*. The same author reckons the *asbestos* kind among the same.

[*n*] The *smectis* or *sestites* and the shoorl or shirl consist of the same kinds of earth as the *asbestos*, except the *calcareous* earth; and is likewise contaminated with a small portion of iron. See *Bergman Dissert. de Asbesto. The Editor.*

b. Yellow.

b. Yellow.

c. Red and white, from the Lands-End: the soap earth, from Switzerland: it looks like Castile-soap.

S E C T. 56. (Additional.)

Magnesia mixed with siliceous earth is found in various parts of the world, particularly in the East, in veins of moderate thickness, and is the substance of which the large Turkey tobacco-pipes are made. It is called by some *spuma maris*, and is the *meerschaum* of the Germans: (also *keffekill*. § 84. Cronst.). It is probably what the Canadians call *terre à chalu-meau*, found in North-America.

It is of a white or yellow colour, soapy feel, and moderately hard: it becomes harder in a moderate heat. In the state we receive it, that is baked, does not effervesce with acids; and is difficultly soluble therein.

According to the analysis of Mr. Wiegleb, it consists of equal parts of magnesian and siliceous earths.

A mixture of this earth with the calcareous earth and iron, is found near *Thionville* in the French part of *Luxembourg*, which is of a blue colour: and contains most calcareous earth, also iron, and a little argill, with some petrefactions.

Another of an olive colour is found in the same place: it contains no argillaceous earth, though both seem like clay; this last is used in pottery.

Also a mixture of this earth with clay, talc, and iron is found in *Silesia*. This is of a greenish yellow: it is in a loose form, of a greasy feel: and according to Margraaf, it contains one third part of its weight of magnesia. *Kirwan*.

S E C T. 57. (80.)

B. Steatites or soap rock.

1. Solid and compact, *Particulis impalpabilibus solida*;

a. White, or light green, from Risver, in Norway, Bareuth, and Sikfioberget, at Norberke, in Westmanland.

b. Deep green from Salberg, in Westmanland, Swartwik, in Delarne, Jonuswando, in Lapland, Salvisto, at Tamela, in Finland, &c.

c. Yellow from Juthyllen, at Salberg, Torrakeberget, at Gosborn, in the province of Vermeland, and China [*o*].

SECT.

[*o*] It is a very difficult matter to specify all the varieties of the soap-stones in regard to their hardness or softness, since they cannot be compared with any standard measure. Those from Risver, Sikfioberg, and China, are a great deal harder and more solid than the English kind, from the Land's End, which

S E C T. 58. (81.)

C. Solid, and of visible particles, *Solida particulis majoribus*; serpentine stone, *Lapis serpentinus*.

1. Of fibrous and coherent particles, *Lapis serpentinus fibrosus*.

which breaks between the fingers; but are soft in comparison to that from Salberg, which is there called *serpentine*, although both these varieties may indiscriminately be made use of for cutting and turning. The soft ones, however, are not so apt to crack, in working, as the harder. But none of these varieties is found in the rock, without being interspersed with the unctuous clefts. When they are too many, too close to one another, and make the stone unfit for use, they are in this case called by the Swedish miners, *skiolige*; and of this kind is a great quantity found at Salberg and Swartwik. Most part of the soap-rock, which is found in Sweden, is likewise mixed with glimmer or mica, and then it is called *telgsten*, that is *ollaris*. *The Author*.

The specific gravity of the steatites is from 2,433 to 2,780. It is not easily diffusible in water, nor rendered ductile by mixture with it: it does not effervesce with acids, and is very slowly and only partially soluble in them.

In fire it hardens, and becomes whiter; but is infusible *per se*.

It is imperfectly melted by mineral alkali and microcosmic salt: but more perfectly by borax. It is apt to corrode the crucibles: and the small quantity of iron it contains, is in a semiphlogisticated state. *Kirwan*.

Its analysis will be found in the table at the end of § 73. *The Editor*.

This is composed, as it were, of fibres, and might therefore be confounded with the asbestus, if its fibres did not cohere so closely with one another, as not to be seen when the stone is cut and polished. The fibres themselves are large, and seem as if they were twisted.

a. Deep green.

Is sold for the *lapis nephriticus*, and is dug at some unknown place in Germany [o*].

b. Light green, from Skienshyttan, in Westmanland; is used by the plate-smiths, instead of French chalk.

[o*] Probably from Bohemia and Boscith. *Brun.*

S E C T. 59. (82.)

D. Fine grained serpentine stone, *Serpentinus particulis granulatis*, the Zoebnitz serpentine.

- a. Black.
- b. Deep green.
- c. Light green.
- d. Red.
- e. Bluish grey.
- f. White, these colours are all mixed together in the serpentine stone, from Zoebnitz, but the green is the most predominant colour,

S E C T. 60. (83.)

E. Porcelain earth mixed with iron, *Terra porcellanea marte mixta*. This is

A. Diffusible in water.

- a. Red, *la terre rouge*, from Montmartre, and China.

The water-clinkers which are imported from some certain places in Germany, seem to be made of this kind,

B. Indurated.

- 1. Martial soap earth, *Creta Brianzonica martialis*.

- a. Red, from Jasberg, in Norway.

It is likewise mixed with some calcareous matter.

2. Martial soap rock, *Steatites martialis*.

a. Black, from Sundborn, in Dalarne, Tor-rakeberget, in Wermeland, Offerdal, in Jemtland.

b. Red, from Siljejord in Telemarken, in Norway [*p*].

S E C T. 61. (265.)

F. The *Telgsten* of the Swedes, *Lapis ollaris*. *Saxum compositum steatite et mica* [*q*].

a. Light grey, from Fahlun, and also Byx-berget at Norberke.

b. Whitish yellow, from Sikfioberget in Norberke.

[*p*] Since the iron renders the so called refractory clay, as well as other clays, more easily fusible than they really are by themselves; it might be queried, how it can be determined, of what species of argillaceous matter these consist? To this it is answered, that they are found together in the same beds with the porcelain clay: that they have all the same external signs, and differ from it only in the colour, being red, brown, or black, in regard to the contained metal: that they are more refractory in the fire than any other martial clay; and that, though they may be reduced so as to resemble a black or iron-coloured slag, they yet retain their form. *The Author*.

[*q*] *Gneis*, in Saxony, is the name of a rock-stone, consisting of glimmer, *lapis ollaris*, and quartz; the proportion, and the manner in which these parts are joined together, form several varieties. *Brun*.

c. Dark

c. Dark grey, from Riddarshyttan.

d. Dark green, from Salvisto in the parish of Tamela in Finland.

This is employed with great advantage to build fire-places and furnaces, &c. and when it is flaty, the extremities of the strata must be turned towards the fire,

S E C T. 62. (Additional.)

Observations on Serpentine.

In respect to colour as well as composition this stone is susceptible of great variety; for it is found either white, green, brown, reddish brown, yellow, light blue, black, spotted, or streaked with veins of various colours. Its texture is either indistinct, obscurely laminar, or fibrous. It is harder than soap rock, though not so hard as to give fire with steel. It is less smooth to the touch, but susceptible of a good polish, looks like marble, and is often in thin plates semi-transparent.

Its specific gravity is from 2,400 to 2,650. It does not effervesce with acids, but is slowly and partially soluble in them. It melts *per se* in a strong heat, and preys on the crucibles. In a lower degree of heat it hardens.

According to the analysis of M. Bayen, 100 parts of it contain about 41 of silice (which he takes rather to be mica); 33 of magnesia; 10 of argill; 12 of water, and about 3 of iron. The
serpentine

serpentine of Corsica contains a larger proportion of argill, and a smaller of filex.

It has many varieties; being found (1) veined or spotted with green steatites, (2) red with veins of asbestos, (3) red, green, yellow, or black with veins or spots of white calcareous spar, is called *potzevera*. The black is called *nero di prato*; the green *verde di Suza*; but these names are not restrained to this species. (4) Veined or spotted with gypsum, (5) veined or spotted with baroselenite, (6) veined or spotted with shistus. And (7) with veins of quartz, felspar, or shoerl. *Kirwan's Elem. of Mineralogy*.

What is commonly called *serpentine*, is a true *lapis ollaris*; but being variegated with green, yellowish, and brown spots, like the skin of some common serpents, it is called by that name. Great quantities of this stone are found in Italy, and Switzerland, where it is often worked into the shape of dishes and other vases. *Fabroni*.

And the *Gabro* of the Italians is nothing else but a kind of serpentine. *Edit. from Kirwan*,

S E C T. 63. (93.)

The micaceous kind, *Terræ micaceæ*. The Glimmer, Daze, or Glift.

These are known by the following characters:

1. Their texture and composition consist of thin flexible particles, divisible into plates or leaves, having a shining surface.

2. These

2. These leaves, or scales, exposed to the fire, lose their flexibility, and become brittle, and then separate into thinner leaves: but in a quick and strong fire, they curl or crumple, which is a step towards fusion; though it is very difficult to reduce them into pure glass by themselves or without addition.
3. They melt pretty easily with borax, the microcosmic salt, and the alkaline salt: and may by means of the blow-pipe, be brought to a clear glass, with the two former salts. The martial mica is, however, more fusible than the uncoloured ones [q*].
There is not yet discovered any loose earth of this kind, but it is always found indurated [r].

[q*] Its mean specific gravity is 3,000. *Fabr.*

[r] However, such as it is, it may be advantageously employed to purify muriatic salt, or nitre, by a decomposition of its heterogeneous parts. *Fab.*

S E C T. 64. (94.)

A. Colourless or pure mica; Daze, Glimmer, or Glist, *Mica alba, sive pura* [s].

1. Of large parallel plates, *Mica constans lamellis magnis parallelis*. Muscovy glass, *Vitrum Muscoviticum* [t].

Is transparent as glass; found in Siberia and Elfdalen in the province of Wermland.

2. Of small plates, *Mica squamosa*, from Silberberget, at Runneby, in the province of Blekinge.
3. Of fine particles like chaff, or chaffy mica, *Particulis acerosis*.
4. Of twisted plates, crumpled mica, *Mica contorta, talcum officinale*.

[s] The specific gravity of mica is from 2,535 to 3,000 when loaded with iron. One hundred parts of the colourless kind contain 38 of filix, 28 of argill, 20 of magnesia, and 14 of the most dephlogisticated calx of iron. Martial mica contains besides 10 or 12 per cent. of a more phlogisticated calx of iron, from whence its various colours are derived, and a proportionally smaller quantity of the other ingredients. *Kirwan*.

[t] Muscovy talc differs externally from mica only in being more soft and soapy to the touch. It contains 50 parts of filix, 45 of mild magnesia and 5 of argill in one hundred parts. Venetian talc is white, grey, yellowish or greenish and semi-transparent. It is much more tender and brittle than mica, and is so soft that it may be scratched with the nail. Its specific gravity is 2,729. *Kirwan*.

S E C T. 65. (95.)

B. Coloured and martial glimmer, *Mica colorata martialis*.

a. Brown semi-transparent, from Kola, in Lapland.

2. Of fine and minute scales, *Mica squamosa martialis*.

a. Brown.

b. Deep green, from the mine of Salberg, in the province of Westmanland.

c. Light green, *Talcum officinale*, found in the ollaris, from Handol, in the province of Jemtland.

d. Black, found in the granites, in the province of Upland.

3. Twisted or crumpled glimmer, *Mica contorta martialis*.

a. Light green, in the ollaris, from Handol.

4. Chaffy glimmer, *Mica martialis particulis acerofis*.

a. Black, is found in the stone called *hornberg*, which occurs in most of the Swedish coppermines; for instance, those at Norberg, Flodberg, &c.

5. Cristallised glimmer, *Mica drusica*.

1. Of concentrated and erect scales, *Drusa micacea constans squamis concentratis perpendicularibus*. *Caryophylloides*.

2. Of

2. Of hexagonal horizontal plates, *Drusa micacea constans squamis hexagonis horizontalibus*.

This is found in the mines of Salberg in the province of Westmanland [u].

S E C T. 66. (96.)

Observations on the Micæ or Glimmers.

The stones belonging to this order are by most authors considered as apyri, which they really are in some degrees of heat, and when they are mixed with certain bodies; but they may at the same time with equal propriety be called vitrescents, because they melt with that degree of fire in which neither quartz nor limestone are in the least altered; and are still more readily fused, when mixed with a martial earth, either by nature or art: hence if the *hornberg* is naturally mixed with copper ores, as is frequently found in Sweden, it is no way detrimental to the smelting of them, as they commonly contain a sufficient quantity of sulphureous acid, which scorifies the iron. But when the glimmer is

[u] These two species of *druse*, or groupes, are often found in collections.

Some tin-floors at *Zinmoald* in Bohemia contain most sorts of glimmer, and they are sometimes very rich in tin-stone. *Brun.*

mixed

mixed with quartz, it may perhaps be impossible to melt it, because it renders the quartz so compact, as to prevent it from cracking, which may be seen on the rock-stone (Sect. 262.): the mica does the same, when it is interspersed in an apyrous clay; and this is the reason why the ollaris so strongly resists the fire [w].

The martial mica in a calcining heat acquires a yellow shining colour, which has induced many to examine it for gold; but nothing can be obtained from it except iron, which may be dissolved or extracted by means of *aqua regis*: although a late German author has pretended that he produced from the mica an unknown semi-metal, which resembled iron mixed with zink. Nevertheless he owns, that he has not examined the semi-metal, and that for obtaining it he used a flux, composed of several metals, some of which probably united with the iron in the mica: wherefore it is probable we shall never hear more of it.

[w] Mr. Margraff asserts that he has obtained Epsom salt from talc; and Mr. Fabroni observes that in decomposing the acid of nitre by means of a micaceous substance, as soon as the acid is distilled, there is some other substance as yet unknown, which sublimes at the end of the operation: he adds that on employing *aqua regia* or *marine acid* with this substance, the yellow colour which results from the solution, seems to indicate that there is some part of iron in it. Finally Mr. Monnet confirms this last assertion, as he found that phlogisticated alkali and solution of galls produce a blueish colour with that of mica: and adds that its component parts are the same as those of the asbestos, excepting only that it contains much less of iron than this last. *Edit.*

Some

Some of the micaceous kind seem fat and unctuous, and others harsh and dry: it is not improbable that the former may contain a phlogiston, although this cannot be extracted from them in form of a pure *oleum talci*. But since talcs and micas resemble each other so much in other particulars, there is no reason for making them two distinct genera [*].

The *talc cubes*, as they are called, which have the figure of alum, and are sometimes found in the copper-mine of Falun, in the province of Dalarne, and which are very much valued by some fossilogists, are, when broke, found to consist of an iron ore, often mixed with a yellow or marchasitical copper ore, and only covered with a very thin coat of mica.

[*] Many mineral substances may happen to have that glittering or shining appearance of common mica, without really being of the same genus. This we are encouraged to assert from what is observed in some artificial productions, one of which I was lately favoured with by my ingenious and worthy friend, Mr. Josiah Wedgewood, F. R. S. who has carried to such an extraordinary perfection the English pottery, that it far exceeds whatever is known both of the antient or modern manufactures of the kind, on account of its fine and various texture, hardness, and elegant forms. The production I speak of as resembling mica, was an unexpected result from vitriol calcined to redness, then mixed (without being washed) with common salt: and calcined again, under a muffle, with a somewhat stronger heat, about the tenth degree of his new and useful thermometer described in the volume of the Philosophical Transactions for 1782. It was of a dark purple colour, and the shining particles were so brittle, as to show their glassy form, very different from these of the real mica. *The Editor.*

The

The transparent Muscovy glass is used for windows, and upon all occasions where panes of glass are wanted. Perhaps it might also be advantageously employed to cover houses.

The twisted or crumpled mica, which is found at Hardol in Jemtland, is there manufactured into kettles and other vessels, as also for hearths of chimnies; and the powder which falls in the working, may be mixed with the common salt for the distillation of the muriatic acid.

S E C T. 67. (102.)

The Asbestos kind, Asbestinae.

These are only yet discovered in an indurated state: their characters are as follows;

1. When pure, they are very refractory in the fire.
2. In large pieces they are flexible.
3. They have dull or uneven surfaces.
4. In the fire they become more brittle.
5. They do not strike fire with the steel.
6. They are not attacked by acids.
7. They are easily brought into fusion by borax or alkaly.

In this order are included both those varieties which by fossilogists have been mentioned

under the names of *Amiantus* and *Asbestus*, and have often been confounded together [y].

S E C T. 68. (103.)

1. *Asbestus*, which is compounded of soft and thin membranes, *Asbestus membranaceus*; *Amiantus Wallerii*.

A. Of parallel membranes, *Asbestus membranis constans pallelis*: *Corium*, five *Caro Montana*, Mountain-leather.

1. Pure.

a. White, from Salberg in Westmanland.

2. Martial.

a. Yellowish brown, from Storrginningen, at Dannemora, in the province of Upland.

This melts pretty easily in the fire to a black slag, or glass.

[y] The specific gravity of the *asbestus* is from 2,500 to 2,800. It consists of *magnesian* earth, with a larger quantity of the *siliceous*, and a lesser of *calcareous* and *argillaceous* earths, contaminated with a small quantity of iron. *Bergman's Dissert. de Asbesto.*

The *amiantus* consists of *magnesian* earth, with a larger quantity of *siliceous* and a lesser of *calcareous*, *ponderous* and *argillaceous* earths, contaminated with a small portion of iron. Its specific gravity is 2,913. *Kirwan and Bergman.* See the *Table* at the end of § 72.

SECT.

S E C T. 69. (104.)

B. Of twisted soft membranes, *Asbestus membranis constans contortis: Suber montanum*, Mountain cork.

1. Pure.

a. White, from Salberg in Westmanland.

2. Martial.

a. Yellowish brown, from Dannemora. This has the same quality in the fire, as the martial mountain leather.

S E C T. 70. (105.)

2. Of fine and flexible fibres, *Asbestus fibrosus: Asbestus*, or earth flax, *Asbestus Wallerii*.

A. With parallel fibres, *Asbestus fibris constans parallelis: Byssus*.

1. Pure and soft.

a. Light green, from Schelkowa Gora in Siberia.

b. White, from Ulrica's Ort in the mine of Salberg in Westmanland: it is there found together with mountain leather.

2. A little martial, and more brittle.

a. Greenish, from Bastnas Grufva, at Ryddarhyttan in Westmanland. There it forms the greatest part of the vein out of which the copper ore is dug; a great part of it is consequently melted together with the ore, and is then brought to a pure semi-transparent martial slag or glass.

S E C T. 71. (106.)

B. Of broken and recombined fibres, *Asbestus fibris constans abruptis et conglutinatis.*

1. Martial.

a. Light green, from Bastnas Grufva at Riddarhyttan [z].

S E C T. 72. (107.)

Observations on the Asbestus kind.

I am much inclined to believe that the Asbesti, as well as the Micæ, are produced from an argillaceous earth, both because they become brittle in the fire, which is a proof that they harden, and because they become more fusible by the admixture of a martial earth: but as the method nature makes use of for this change is unknown, it might perhaps in other respects be necessary, not to force the earths together, for some slight reason, within the compass of a few orders.

The Siberian Asbestus, which may be considered as the principal and chief of the fibrous kind, is, as it were, consumed by the flame of a blowpipe, and does not leave any certain mark of fusion; but it melts readily with borax to a clear and colourless glass.

[z] It will be observed in a Note under the title of Cockle, or Shirl, that the asbestus is often confounded with it. *The Author.*

The natural store of this kind is in proportion to its œconomical use, both being very inconsiderable. It is an old tradition, that in former ages they made cloaths of the fibrous asbesti, which is said to be expressed by the word *Byssus*; but it is not very probable, since, if one may conclude from some trifles now-a-days made of it, as bags, ribbons, and other things, such a dress could neither have an agreeable appearance, nor be of any conveniency or advantage. It is more probable that the Scythians [a] dressed their dead bodies, which were to be burnt, in a cloth manufactured of this stone; and this has perhaps occasioned the above fable.

Paper is likewise made from this stone, only to shew its fixity in the fire, and to procure some esteem and value to this curious substance.

It was reported some years ago, that the French searched for asbesti, in order to mix it with the tar for preserving houses and ships from fire; but the question is, if the asbesti can be of more service than pounded mica, or other earthy dust employed to the same purpose.

[a] Some of the Romans did the same. In the year 1756 or 1757 I saw a large piece of asbestus-cloth, found in a stone tomb, with the ashes of a Roman, as appeared by the epitaph, but I have forgotten the name. It was kept (and I think the tomb likewise) in the right-hand wing of the Vatican library at Rome, among other antient and modern curiosities. The under-librarian, in order to shew that it was indomestible, lighted a candle, and let some drops of wax fall on the cloth, which he set on fire with the candle in my presence, without any detriment to the cloth. Its texture was coarse, but much softer than I could expect. *Edit.*

Table of thirteen substances belonging to the *Magnesian* earth, with the contents of each, that have been analysed by Sir T. Bergman.

	Ponderous vitriolated earth.	Calcareous earth.	Magnesian earth.	Argillaceous earth.	Siliceous earth.	Calx of iron.
1. Amiantus from Tarentaise in Savoy, composed of shining long fibres, opaque, and very soft, which may easily be separated from one another	6	6,9	18,6	3,3	64	1,2
2. Asbestus from Coricy in the Asturias in Spain, white, and its fibres very fine and soft, easily separable from one another		10,5	12,9	3,3	72	1,3
3. Ditto from Bastanaes at Riddarhyttan, of a greenish brown colour: its fibres very fine and soft, and brittle		6	16,8	6	67	4,2
4. Ditto from Groenge in Dalecarlia, its fibres are of a dark brown, parallel, pretty rough, disposed in little bundles, differently inclined to one another		12,8	16	1,3	63,9	6
5. Ditto from the island of Crete, white and rough, its fibres are short, and applied over one another like the tiles of a house		14,3	28,8	1	53,9	2
6. Ditto from Pehsberg in Vermeland, it is brown, the fibres being parallel, and rough: and not easily separable		12	13,7	1,7	62	10,6

Ponderous vitriolated earth.	Calcareous earth.	Magnesian earth.	Argillaceous earth.	Siliceous earth.	Calx of iron.
	13,9	17,2	2,7	64	2,2
	10	22	2,8	62	3,2
	12,7	26,1	2	56,2	3
	7,7	13,6	2,7	74	2
	0	17,1	2	80	0,9
	6	12,7	2	72	7,3
	9,3	20	2,7	64	4

7. Ditto from Sverdsjöe at Swartwik in Dalecarlia, one species found there, is white with very fine soft fibres, intermixed with some little bundles of hard fibres, which were separated as impure and greatly ferrugineous
8. Ditto from the silver-mine at Sahlberg, is white, compact, and as elastic as cork: it is the *suber montanum*, its fibres are interwoven in different directions
9. Ditto from the same place, of a lamellated soft texture like leather, called *corium montanum*
10. Ditto steatiforme from Swartwik in Dalecarlia, is of a pale green, of a shining rough striated surface, composed of fine long white fibres so joined together as not to be distinguishable easily in their joints
11. Steatites from Swartvik, is found with the above asbestos, of a green colour, with irregular thin cracks
12. Schörl from Groenge of a white greenish colour, composed of small parallel shining, and brittle fibres, like the above asbestos from Bafanaes, N^o. 3. § 74 of Cronstedt
13. Schörl from Zillerthal in Tirol, is green, and so hard as to act on glass: it is composed of parallel fibres in different diverging bundles as described by Cronstedt in § 74. b.

ORDER THE FOURTH,
SILICEOUS EARTHS.

S E C T. 73. (40 and 41.)

Terrae Siliciae.

THE siliceous earth is, of all others, the most difficult to describe and to distinguish perfectly: however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated state it is hard, if not in regard to the whole, yet at least in regard to each particle of it, in a degree sufficient to strike fire with steel, and to scratch it, when rubbed against it, though the steel be ever so well tempered.
2. When pure, and free from heterogeneous particles, it does not melt by itself, neither in a reverberatory, nor in a blast furnace.
3. After

3. After being burnt, it does not fall to a powder, neither in the open air, nor in water, as the calcareous earth does, but becomes only a little looser and more cracked by the fire, unless it has been very slowly, and by degrees, heated.
4. It excites no effervescence with acids.
5. In the fire it melts easiest of all to a glass with the fixt alkaline salt; and hence it has got the name of Vitrescent, though this name is, properly speaking, less applicable to this order, than to a great many other earths [b].

The

[b] To the above we may add the following properties :

6. It is not soluble in any of the known acids, the fluor-acid only excepted. But
7. It may be dissolved by the fixed alkali, both in the dry and wet way.
8. If the fixt alkali is only half the weight of the siliceous earth, it produces a diaphanous and hard glass: but when it is in a double or triple proportion, then the glass deliquesces of itself by attracting the humidity of the atmosphere.
9. It melts easily with borax; but
10. With microscomic salt, it is more difficult, and requires a longer time to melt.
11. This earth has a great analogy to acids, as it is perfectly dissolved in that wonderful natural hot-water-spout above ninety feet high at Geyser in Iceland, where by cooling it forms a siliceous mass. *Editor chiefly from Bergman.*

It is not yet known, whether there be any loose earth of this kind to be found, or whether the indurated one is produced of a clay, either pure, or mixed with the calcareous earth, which afterwards has been dissolved, in order to produce this. I have

The mineral bodies that are comprehended in this order, are, indeed, somewhat different from one another. This difference, however, on first sight may be discerned; but, in regard to their effects in the fire, and other chemical experiments, it cannot be esteemed of any great consequence, at least while we are no farther advanced in the art of decomposing these hard bodies, and as long as no one has thought it worth the trouble and expence to use those means which are already discovered for this purpose; I mean the burning-glass or the concave mirror; and to continue such experiments which Mr. Pott has ingeniously begun, as a basis for his *Lithoognefia*. For want of this there is no other way left, than to consider these bodies as simple substances (how much soever compounded they may be), in the following manner.

have not yet, at least for my own part, found any loose earth that I can suppose to be a siliceous one, except that which remains after stones of this kind are decayed, and which is found in form of a white crust on the surface of those stones that lye to the day, or on the earth. This being afterwards worn off, and carried away by the water, is, perhaps, gathered together in form of strata. In the same manner window-glass likewise moulders in length of time: but it cannot, therefore, be supposed, that any such decayed particles may, without being previously dissolved in some new menstruum, be reduced into their former substance. I am rather inclined to believe, that Tripoli is such a mouldered siliceous earth, and that the method of Nature in producing most of the flinty kind, is such as we do not rightly know, nor have patience to follow, yet imagine that we in some measure imitate it in making of glass, since both these have some effects common with one another. *The Author.*

SECT,

S E C T. 74. (42.)

A. Diamond. Lat. Adamas gemma. Swed. and Germ. Demant. Fr. Diamant [c].

1. Of all stones is the hardest [*d*].
2. It is commonly clear, or transparent [*e*], which quality, however, may perhaps only belong to its crystals: but not to the rock itself from which they have their origin [*f*].
3. Its

[*c*] This precious stone ought to be ranged in a separate order by itself, under the title of *precious earth*, or *terra prae-ciosa incognita phlogisto combinata*, as its basis does not belong properly to any of those earths we know at present. *Fabr.*

[*d*] But it is destructible by the joint action of fire and air; even in close vessels according to Mr. Darcet, who has much enlarged our knowledge of this subject.

If diamonds be reduced to an impalpable powder (by means of rubbing one against the other, which is the only way to powder them) the inflammable principle may be extracted by digestion in the vitriolic acid.

The microcosmic salt penetrates with difficulty the substance of diamonds in fusion. They are still less affected by borax. *Fabr.*

[*e*] Yet diamond powder is of a grey or blackish colour; but this proceeds from extraneous substances, as it becomes whitish on being washed by acids, unless it has been made out of the crust of diamonds, or of those which are black. *Berg.*

[*f*] Diamonds never are found, as far as I know, stuck to any rock, nor in clusters like rock crystals. Tavernier says (page 327 of his second volume), that they are found in a sandy earth, and in the loose earth that fills the clefts of some rocks. That their mines at *Gani*, otherwise called *Coulour*, where

3. Its specific weight is nearest 3,500 [g]. When brought to Europe in its rough state, it is in a form either of roundish pebbles, with shining surfaces, or of crystals, of an octoedral form [b].

a. Colourless,

where six thousand people were at work, are in a marshy ground. At *Soumelpour* the diamonds are found in the bed of the river *Gouel*, whose waters are turned with great labour, into another channel for this purpose: and I am informed by very good authority, that the Brazilian mines of diamonds are worked in the same manner. At *Borneo* it is also in the river *Succadan* that diamonds are found, according to the same *Tavernier*. But what this famous traveller says of certain diamonds which have a greenish crust, is very remarkable indeed! These green diamonds burst into pieces either whilst they are in working to receive a proper shape, or when in the very act of being polished on the wheel (see note b): and he mentions a large diamond, bought by a Jew, named Edward, for which 25 thousand piastres (about 5200 pounds sterling) had been offered when brought to Leghorn, that on being sent to Venice, in order to be cut there, burst into nine pieces whilst polishing on the wheel. This conveys, it seems, the idea of some similarity between diamonds and the *lachryma batavica*, which may perhaps be extended to all hard cristallisations like those of gems. My worthy friend John Whitehurst, F. R. S. who visited (in this summer of 1783) the giants causeway in Ireland, found within the lava of this antient and unrecorded Volcano, some cavities or hollows, filled with well formed crystals of quartz. This seems to indicate, that, for the formation of hard crystalline substances, the action of a strong heat is required in one way or other. *The Edit.*

[g] The specific gravity of diamonds, according to Walle-rius, is from 3,100 to 3,400: Hauksbee judges it to be 3,666: Ellicot 3,519. Brisson 3,5212.

[b] Diamonds commonly crystallize into octoedral forms, which, however, are often found somewhat irregular, especially

a. Colourless, or the diamond properly so called [i]. But it also retains this name when it is tinged somewhat red, or yellow

cially when the surface inclines to crystallize, during the shooting of the whole crystal, and also when several of them unite together into a groupe; in which latter circumstance the one hinders the other from assuming its regular form; and of this I have seen several instances. But the octoedral is not the only regular form which the diamond assumes; I have lately seen a rough diamond, or in its native state, in a regular cube, with its angles truncated or cut off. *Eng.*

Diamonds of a dodecaedral form are not uncommon: those of Malacca are rhomboidal and cubic: and some have been found of fourteen sides or planes.

The substance of diamonds is lamellated, consisting of very thin plates like those of talc, but extremely hard and intimately united, whose direction lapidaries must find out, not only to cleave the ill-shaped diamonds, but to cut and shape them properly. This last operation is performed by rubbing a diamond with another, till it has the required shape. It is afterwards polished in an horizontal wheel of steel, employing the same powder that falls from their rubbings, with common olive oil. But diamonds, whose foliated substance is like wood knots, viz. not in a flat position, cannot be well shaped: and lapidaries call them by the nick name of *diamonds of nature*. See Bomare's Mineralogy, p. 393, vol. I. The art of cutting diamonds was invented in 1476, by Louis de Berquen, a native of Bruges in the Austrian Netherlands. *The Edit.*

[i] The names *oriental* and *occidental* given by Jewelers to this and to all other precious stones, have a different acceptation from the obvious sense, that is to say, the hardest and finest gems are called *oriental*; though many, that are produced in the East, go by the name of *occidental*, when of an inferior kind. And in fact a prodigious number of the finest diamonds and other precious stones have been found in Brazil, which cannot but be reckoned *oriental* ones. This is a general opinion followed both by the great Bergman, Mr. Dutens, Mr. Romé de l'Isle, Valmont de Bomare, &c.

The

low [k]. Being rubbed, it discovers an electrical quality by attracting the mastick [l].

The famous Jeweller Mr. Jeffries in his *Treatise on Diamonds*, asserts very positively that, upon the strictest examination, there is not the least difference between the best Oriental and Brasilian diamonds. *The Edit.*

[k] There are diamonds of all colours, though not deeply so, viz. some incline to the *rose* colour, others to *green*, *blue*, *brown*, *black*: and some have black specks. Tavernier saw one of this last kind weighing about 56 karats in the treasure of the Mogul: he says also, that the mines of Carnatica produce yellow and black diamonds: and Mr. Dutens says (page 13 of his *Treatise*) that he saw a black diamond at Vienna, in the collection of the Prince de Lichtenstein. *The Edit.*

[l] The diamond becomes phosphoric, either by being exposed to the solar rays, or by being made red hot in a crucible on the fire. When rubbed, it attracts small bits of *straw*, *paper*, *feathers*, *hairs* of animals, *silk*, &c. But as to its supposed quality of attracting the mastick, it seems not to be more peculiar to diamonds, than to any other gem, or rather to be an imaginary quality. *Edit. from R. de l'Isle.*

S E C T. 75. (Note to § 42.)

Observations on Diamonds.

These gems are rather too precious to be examined by all possible experimental means; however they are, by reason of their hardness, and the particular form of their crystals, with more propriety looked upon to be produced from their own separate principle [*m*], rather than

[*m*] The phenomena of the diamond during its decomposition clearly shew that it is composed of principles which are peculiar to itself, as the earth which is its basis is reducible to none of the five known earths, already mentioned, Sect. 3. Note *m*. Mr. Bergman kept diamond powder for three hours in a violent fire in contact with the mineral alkali without finding any sensible change in it; but having afterwards extracted the alkali by spirit of salt, the solution afforded by the addition of the vegetable fixed alkali a white precipitate earth, soluble in all the acids, but which with the vitriolic acid, afforded neither allum, nor Epsom salt, nor selenite, nor ponderous spar, and consequently was neither argillaceous, magnesian, calcareous, nor ponderous, or siliceous earth (since it is soluble in all the acids), but a new and distinct species which with the vitriolic acid forms a salt irregularly crystallizable, of a harsh acid taste, and very soluble in water. The phlogiston is united to this earth in a very singular manner: the vitriolic acid takes it up by digestion with diamond powder without becoming sulphureous; but the inflammable matter may be separated from the acid by evaporation: it then forms

than to be ranked among the quartz crystals; being either formed in a single drop, or crystallized out of their matrix; for if the heat of the sun, or the climate, were the cause of the hardness of the diamonds, why is not a quartz crystal on the coast of Barbary harder than one from the province of Jemtland in Sweden? and who can assure us here in Europe, if, at the place where the diamonds are dug, there is any kind of rock, or not, which is the basis or matrix of these precious stones, in the manner as the quartz is of the rock or quartz crystals? The account which Tavernier has given us, about the digging of diamonds at Golconda, agrees with that of the crystals in Jemtland, viz. that they lye bedded in clay within clusters of crystals, and in clefts [n]. Now such of our crystals

forms black combustible pellicles which burn away almost entirely, leaving only a small quantity of white earth. *Berg.* See Note o.

There was a report that Mr. Morveau of the Academy of Dijon, had found a solvent for diamonds. At my request Mr. Bochart de Saron, President of Parliament and honorary member of the Royal Academy of Sciences at Paris, asked Mr. Morveau about it, but he answered in the negative: and added that having thrown a diamond of *one grain* weight into a crucible with fused nitre over the fire, where he left it for a while; after it was cold, he washed the contents in cold water; but instead of the diamond, he only found 10 or 12 grains of earth, which in all probability had been dissolved from the crucible during the operation. *The Edit.*

[n] The chief mines of diamonds are in the Asiatic Peninsula on this side of the Ganges towards the *Gatte* mountains, not only at *Golconda* but in many other parts, as *Coulour*, *Raolconda*, *Bijnagar*, *Noustaflanagar*, *Parteal*, *Latawar*, *Soumalpour*,

crystals are always the clearest, as have never been adherent to the rock, and next to them, such, as by some unknown accidents in nature, have been separated from their basis; but such, as are yet fixed to the rock, are very seldom fit for any use: if this, therefore, should happen to be

Soumalpour and *Malaca*; some of which are now exhausted: besides these, diamonds are found in the island of Borneo; and above all in Brasil, in the province of *Serra do frio* in the place called *Cay de Marin* near the river of *Milbo-verde*. See *Bomare's Mineralogy*, vol. the first, and *Romè de l'Isle's Cristallographie*, vol. the second. As to the soil or mine in which diamonds are found, Mr. Bomare says, that they are sometimes found stuck to rocks, and in clusters like rock-crystals; but this seems to be very seldom the case. See the above Note f to this Section. Edit.

The mean value of diamonds may be easily calculated by the general rule of Jewellers, viz. by multiplying the square of their weight in *carats* by two *pounds sterling*, when the diamond is rough or uncut: but if it is already cut, the square of the double of their weight is to be multiplied by the same value of two *pounds* (or *louis d'or*); or in other words, the simple square of their weight must be multiplied by eight *pounds sterling*. This great difference of price proceeds from the great loss which a diamond suffers in being cut; which comes to the half (and sometimes more than a half) of its weight. N. B. The expence of cutting a diamond amounts to $3\frac{1}{2}$ *pounds sterling* per *carat*: this is not reckoned in the following evaluations. N. B. 2°. each *carat* is generally divided into four *grains*; but each of these grains are smaller than those of the *troy weight*; because, according to Dav. Jeffries, five of them are equal to four *grains* of the *troy weight*: so that one ounce of this last weight contains 150 *carats*, and no more than 480 *grains*. N. B. 3°. The above price of two *pounds sterling* for the *carat*, is for common diamonds without any flaw, colour, or blemish, otherwise their value is much reduced; sometimes to its half; but no diamond is worth cutting, under one *pound* the *carat*.

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Those

be the case likewise with the diamonds, it is no great wonder, that they do not at the very place take any notice of the rock, and still less, that they do not bring any of it to Europe. The clusters

Those of a greater brilliancy, and perfection, may be reckoned at the rate of three pounds the carat, multiplied by the square of the double of their weight, if cut; or else by the square of their simple weight, if they are uncut. N. B. 4. The first of the following diamonds, is *uncut*: the other six are *cut* diamonds.

1. The greatest diamond ever known in the world is one belonging to the king of Portugal, which was found in Brasil: it is still uncut: and I am informed from good authority, that it was of a larger size; but a piece was cleaved or broken off by the ignorant country-man, who chanced to find this great gem, and tried its hardness by the stroke of a large hammer upon the anvil.

This prodigious diamond weighs 1680 *carats*: and although it is uncut, Mr. Romè de l'Isle says (page 208) that it is valued at 224 millions sterling; which gives the estimation of 79,36 or about 80 pounds sterling for each *carat*: viz. for the *multiplicand* of the *square* of its whole weight. But even in case of any error of the press in this evaluation, if we employ the general rule abovementioned, this great gem must be worth at least 5,644,800 pounds sterling, which are the product of 1680^2 by two pounds, viz. much above 5 millions and a half sterling.

2. The famous diamond which adorns the sceptre of the Empress of Russia under the Eagle at the top of it, weighs 779 carats, and is worth at least 4,854,728 pounds sterling, although it hardly cost 135,417 guineas. This diamond was one of the eyes of a Malabarian idol, named Scheringham. A French grenadier, who had deserted from the Indian service, contrived so well as to become one of the priests of that idol, from which he had the opportunity to steal its eye: he run away to the English at Trichinapeuty, and thence to Madras. A ship-captain bought it for twenty thousand rousees: afterwards a Jew gave seventeen or eighteen thousand pounds sterling for it:

clusters or groupes of cristals from Schneckenstein in Saxony, wherein topazes and rock cristals are found promiscuously mixed, having each their different forms, colours, and hardness, fur-

it: at last a Greek merchant, named Gregory Suffras, offered it to sale at Amsterdam in the year 1766: and the late Prince Orloff made this acquisition, as he himself told me here in London, for his Sovereign, the Empress of Russia. Dutens page 19, and Bomare page 389 of his *Mineralogy*, relate the above anecdote. The figure and size of this diamond may be seen in the British Museum in London: it is far from being of a regular form. *The Edit.*

3. The diamond of the great Mogul is cut in Rose; weighs 279 $\frac{1}{8}$ carats, and it is worth 380,000 guineas. This diamond has a small flaw underneath near the bottom: and Tavernier, page 389, who examined it, valued the carat at 150 French livres. Before this diamond was cut, it weighed 793 $\frac{1}{2}$ carats according to Romè de l'Isle: but Tavernier, page 339 of his second volume, says that it weighed 900 carats before it was cut. If this is the very same diamond, its loss by being cut was very extraordinary.

4. Another diamond of the king of Portugal, which weighs 215 carats, is extremely fine, and is worth at least 369,800 guineas.

5. The diamond of the grand Duke of Tuscany, now of the Emperor of Germany, weighs 139 $\frac{1}{2}$ carats: and is worth at least 109,520 guineas. Tavernier says that this diamond has a little hue of a citron-colour: and he valued it at 135 *livres tournoises* the carat. *Dut.* Robert de Berquen says, that this diamond was cut into two: that the Grand Turk had another of the same size: and that there were at Bijnagar two large diamonds, one of 250, and another of 140 carats. This Robert de Berquen was the grand-son of Louis de Berquen who invented out the art of cutting diamonds. *The Edit.*

6. The diamond of the king of France, called the *Pitt* or *Regent*, weighs 136 $\frac{3}{4}$ car.: this gem is worth at least 208,333 guineas, although it did not cost above the half of this value.

7. The other diamond of the same Monarch, called the *Sancy*, weighs 55 carats: it did cost 25,000 guineas: and Mr. Dutens says, that it is worth much above that price.

nish a proof that nature forms the so called precious stones or gems, each from its particular matter or principle [o].

The round diamonds may be supposed to have undergone the same fate with some of the rock crystals, viz. to have been, by changes in the earth, broken from their beds, and by the agitation of waters, ground and rubbed against one another, until they have been rounded or reduced to this form; since they are mostly found amongst sand, and are discovered in places worn down by heavy showers of rain [o*].

A sort of diamond is found, which is said to be very soft, and is called the Jargon [p]; but this
fort

[o] It will appear by the following Section, 86, that the other precious stones have not so great a difference in their component parts, as the author seems inclined to think: but as to the diamond, it is evident, by Note *m* to this Section, that its basis is widely different; since in a heat somewhat greater than that in which silver melts, diamond is intirely volatilized and consumed, it even produces a slight flame, and diminishes common air, just as phlogistic substances do, and leaves a soot: so that the extraordinary conjecture of Sir Isaac Newton, of its being an *inflammable substance coagulated*, is fully confirmed. This is a very proper remark of Mr. Kirwan: and Mr. Ed. H. Delaval made the same observation to me, long before the publication of Mr. Kirwan's Book. *Edit.*

[o*] Davila had such a piece in his Catalogue N^o 725, and Mr. Stieglitz at Leipzig has got it from him, and placed it in his great collection, where I have seen it. *Brun.*

[p] The Jargon is so called by the English Jewellers. Its natural shape is not yet known, it being found in form of pebbles in the Indies, where it is split into thin pieces, and thus sent to Europe.

The Jargons are of different colours, viz. white, light yellow, and brown. According to some Lapidaries, they come
nearest

fort is still unknown to me, nor have I found that any experiments have been made relating to its hardness and principles [9].

I have seen in the collection of the Mine-Master M. Van Swab, a diaphanous octoedral cristal of fluor, which according to those who only mind the figure, ought to be called a diamond.

nearest to the sapphires in hardness; and as they have, when cut and polished, a great resemblance to the diamond, they are also by some called *soft diamonds*, and one may easily be imposed upon in purchasing these for true diamonds when they are made up in any sort of Jeweller's work. *Eng.*

[9] Mr. de Bomare says that the jargon is found in Brasil: but, according to Mr. Romè de l'Isle, it is from Ceylan that this hard stone comes to Europe: its specific gravity is 4416, viz. nearly equal to that of *ponderous spar*: its form consists in two tetrahedral pyramids of equal sides, separated by a short prism, so that the jargon is properly of a dodecahedral form. On its being exposed by Mr. d'Arcet to a violent fire, its surface was a little vitrified, as it stuck to the porcelain-test in which it was set; from whence it appears that the jargon has not the least affinity to the diamond, which is destructible by fire, as may be seen in the Notes *m* and *o* to this Section. *The Editor.*

S E C T. 76. (43.)

The Ruby.

B. Red ruby. Adamas ruber. Rubinus [r].
Which, by lapidaries and jewellers, is, in regard to colour [s] divided into,

i. The

[r] The ruby is cristallised into an octoedral form, as well as the diamond (*), and differs also very little from it in hardness and weight. I have, therefore, considered these two, as being of one and the same kind, and that with as much right as others, who have ranked them under the rock cristals, which last are more regular than any other earthy substance, as they assume, during their cristallisation, a determined form, viz. the hexagonal with a point at one or both ends. *The Author.*

But later experiments show how widely diamonds differ from any other gems by their constituent parts. This fully appears by the Notes *m* and *o* Sect. 75: and as to the hardness of the ruby, as well as of the other strong substances, the reader may consult the table of Mr. Quist, inserted at the end of the Siliceous earths. *The Edit.*

[s] According to Tavernier, vol. 2. p. 356, and Dutens, p. 23, all coloured hard stones are called *rubies* in the East-Indian mines, adding to each its different colour for distinction sake, but there are also some soft stones of this kind which they call *Bacan*: and Wallerius, as well as Romè de l'Isle, rightly assert that the oriental (the hard and brilliant) rubies, sapphires and topazes are the very same stone, the co-

(*) What I have observed about the octoedral form of the diamonds, may also be applied to the rubies. Besides, the rubies are also sometimes found of irregular hexagonal figures. *Eng.*

lour

1. The ruby, of a deep red colour, inclining a little to purple [t].

lour excepted: certainly they have the same form, and some are partly *red*, and partly *blue*, *yellow*, or quite *colourless*. As to their colour, it proceeds from the martial mixture which enters into their composition. See § 86 and its Notes. Rubies are found in the Capelan mountain of Pegu, at Caos, Ava, Bifnagar, Calicut, Cananor, Ceilan, and Brasil. They are found in the sands of rivers of a red colour, in an argillaceous earth of a hard texture, and of a greenish colour; and sometimes they are adherent to red rocks.

Tavernier speaks of 108 rubies in the Mogul's throne, from 100 to 200 carats, and of a round one of almost two ounces and a half: and Robert de Berquen speaks of one of 244, another of 123, and another of 209 carats. *The Edit.*

[t] This is the *carbunculus* of Pliny; but all red gems were so called by the Antients. Those of a deeper colour are called *almandini* according to Wallerius, and the Jewellers call this the *oriental ruby* on account of its hardness and brilliancy. See Note i to Sect. 74. By the experiments of Mr. d'Arcet the ruby does not lose its colour in the greatest fire: but Henckel, by means of a burning glass, softened it so as to receive the impression of a seal of jasper. *Dutens.* This ruby is the hardest gem after the diamond. *Bergm.* And being rubbed becomes electric. *R. 7.*

Its specific gravity is from 3,180 to 4,240. *Berg.* According to Brisson it is = 4,283.

Its texture is foliated like that of diamonds: it is fusible with borax in a violent and long continued heat; and forms a transparent glass of a pale green: it does the same with *microcosmic salt*: but with sedative salt, or mineral or vegetal alkali, the glass is opaque and of various colours. See the various experiments of Messrs. Bergman and Achard on this kind of gems: and the Table at the end of Sect. 86.

A perfect ruby above $3\frac{1}{2}$ carats weight, is more valuable than a diamond equally heavy: if it weighs one carat, is worth 10 guineas: if two carats, 40 guineas: if three carats, 150 guineas: if six carats, above 1000 guineas. *Dutens.*

2. Spinell, of a *ponceau red*, (*viz.* of a bright corn-poppo-flower colour) [*u*].
3. The balafs, pale red, inclining to violet. This is supposed to be the mother of rubies [*w*].
4. The rubicell, reddish yellow. However, all authors do not agree in the characters of these stones [*x*].

[*u*] The form of the ruby spinell is octoedral: its specific gravity is 3,760: of that from Brasil 3,531. *Romè de l'Isle* from *Briffon*.

These rubies are found in Hungary, Silesia, Bohemia, and some in Brasil. *Bomare* and *R. de l'Isle*.

The value of these rubies is reckoned at the half of diamonds of the same weight. *Dut.*

Rubies are artificially made from topases of Brasil, of a smoaky appearance, by giving them a gradual heat in a crucible filled with ashes, until it is red-hot. See R. J. and Dutens, who quote the History of the Royal Academy of Sciences of Paris for the year 1747. It was Dumelle, a Jeweller, who communicated this secret to Mr. Guetard of the Royal Academy of Sciences at Paris. *The Edit.*

[*w*] This comes chiefly from Brasil, although some come also from the East Indies. The value of the balafs-ruby is at the rate of 30 shillings per carat. *Dut.*

[*x*] These come also from Brasil, but it is said that their colour is lost in the fire: if so they must be of a different nature from the Brazilian topaze, which gets a red colour from fire, as was said Note *u*.

N. B. The *Rubino di rocca* of the Italians, or *rubinus rupium* is a true garnet, of a deep red and violet, or of the amethyst colour. What is called *ruby of arsenic*, or of *sulphur*, is the realgar: the *ruby of zinc* is the *red blend*: and the *ruby of silver* is the *red silver ore*, &c. *Bomare*.

S E C T. 77. (44.)

The Sapphire.

C. Sapphire. Sapphirus gema. It is transparent, of a blue colour, and is said to be the hardest next to the ruby, or diamond [y].

In consequence of the ignorance I plead in regard to these sorts of stones, I have given this a place by itself.

Sapphires are said to be found in Alsatia, at St. Amarin, but accounts of this kind are in general not to be depended upon, as the fluors are frequently met with in collections and in the

[y] The sapphires in their rough or native state cristallize most generally in two oblong hexagonal pyramids pointed at their tops, and joined at their bases: yet they are sometimes found of an hexagonal columnar form. In the fire they lose their blue colour.

I have found some of the deep blue sapphires, and some of a milky colour, which, when looked through, varied their colours in the same manner as the milky bluish opals. This is however no reason why those opals should be marked under the name of sapphire, and less so since there are also agates found of the same quality. This might rather give rise to a question, whether the name of *milky or bluish opal* is not to be considered as a vague term, since that principal quality is found in stones of a somewhat different nature, though they all belong to the stinty order? *Eng.*

drug.

druggists shops under the name of sapphires, when they are of a deep blue colour; not to mention that the quartz is always termed a precious stone, whenever it is found clear and of a fine colour. The sapphire is said to lose its blue colour in the fire. Those which are but little tinged, are called white sapphires. The sapphire is seldom found of a very deep blue colour, and free from parallel flaws which run through it [z.]

SECT.

[z] The fine hard sapphires, or, as jewellers call them, the oriental ones, are of the same kind as the ruby and the topaz, their colour excepted. See notes to Sect. 76.

The King of France has one with a yellow stripe of a fine topaz in the middle. *R. J. & R. de Berg*. Some are found half green and half red. This substance is foilated like the ruby. Those from *Puy* in Auvergne seem to approach to the true sapphire, by their form and their specific gravity: but they lose both their colour and transparency by fire, and become black, and even vitrify, according to *R. J.* which proves that they are of a different kind.

It is said that sapphires lose their colour by fire, and remain so hard and transparent as to pass sometimes for diamonds. But Mr. Achard found that they are not altered in the least by fire, in colour, hardness, nor weight; however, these circumstances may not be common to all sapphires.

The sapphire is the third in hardness, the ruby being the hardest of all after the diamond. *Berg*. And becomes electric by being rubbed. *R. J.* Its name was taken from *Σαπφειρ*, the place where they were found, according to *Lemery*, quoted by *Bomare*. But it is evident from Pliny (Book 37. chap. 9.) that the sapphire of the antients was our lapis lazuli. *The Edit.*

Its specific gravity is from 3650 to 3940. *Berg*. According to *R. J.* the oriental is = 3.994: the Brasilian = 3.1307: and that from *Puy* = 4.0769. The sapphire when powdered is fusible with

S E C T. 78. (45.)

The Topaz.

D. Topaz. *Topazius gemmæ* [a].

This is a precious stone, which, when rough and perfect, is sold in a crystallized form. At
Schneck-

with *borax*, or with *micoromic salt* into a transparent glass, as well as with *magnesia alba*. *Berg.* and *Achard* found nearly the same results from the analysis of this gem.

They are found in the same place as rubies: and those called occidental, are also found in S.beria, Bohemia, Alsace, and Auvergne. *Romé de l'Isle* speaks of one of this last place, which was entirely *green* or *blue*, according as the side it was looked through.

A good sapphire of ten carats is valued at 50 *guineas*. If it weighs 20 carats, its value is 200 *guineas*, but under 10 carats it may be valued by multiplying the carat at 10 *shill.* 6 *pence* into the square of its weight. *Dut.*

Sapphires are preferable to common rubies, for jewelling the pallets of escapements, and the holes of wheel-pivots, in astronomical watches and clocks, on account of the homogeneous hardness of their substance: because there are red stones which are called rubies, but are not uniformly hard. The jewelling watch and clock work is a very material Improvement of the English artists, who stand unrivalled in the whole world for the regularity of their time-keepers. *The Editor.*

[a] According to Pliny, (book 37. chap. 8.) this gem took its name from an island in the Red Sea, where it was first found; but it is evident from his words that it was some kind of *lapis ollaris*, *fusible spat*, or other kind of stone of a green-

Schneckenstein in Saxony, these crystals are found of a prismatical octoedral form, with no points, but flat, and with some facets at the top; perhaps the oriental topazes have another figure [b].

Ex-

greenish-yellow cast, that the antients called *Topaz*; since he speaks of a topaz of a greenish colour. and 4 cubits large, viz. above 6 English feet (≈ 68.476 , French inches ≈ 72.978 English inches;) which cannot be applied either to our topaz or to our chrysolite, as some pretend. It appears, however, by the following chapter of this same author, that our topaz was called Chrysolite by the antients, as its name indicates: but what he says of one Bocchus, who had seen one of those gems of 12 Roman pounds weight, or 10.78. pounds troy, is not incredible: since there is now a rough topaz in the Princes cabinet at the Hague, of the shape of an egg, that is upwards of seven inches in length, and must consequently weigh considerably more than the above. *Edit.*

[b] I have some rough Brazil topazes, which are prismatical; and of a rhomboidal quadrangular figure, pointed at one end. It is very likely, that they, as well as many other crystals, may be pointed at both ends, when nothing has impeded them during their crystallization.

Besides these, I have some fragments of other topazes, likewise said to be from the Brazils, which are all of them prismatical, but plainly shew, that some are pentagonal and others regular hexagons with points.

The topazes lose their colour in the fire, but some of them turn red in a certain degree of heat, and are therefore very much used instead of the pale rubies, and even are often sold as such. *Eng.* See Note u to Sect. 76.

The topaz is of a lamellated structure, like the other gems: it is the third in hardness after the diamond, and on being rubbed, becomes electric. Its form is prismatic of 6 or 8 sides, ending in two quadrangular pyramids. Some are striated; some are of a rhomboidal figure, and some are even of a cubic form. *R. J. & Dut.*

I

Their

Experiments by fire have been made on the Schneckenstein topazes by Mr. Pott, as may be seen in his *Lithoëgneſia* [c]. To this kind I refer,

- a. The pale yellow topaz, which is almost colourless, and is found at Schneckenstein.

Their specific gravity is from 3.460 to 4.560. *Berg.* According to *Brison* = 4.0106. and those of *Braſil* = 3.5365. *R. 7.*

The Topaz appears white when reduced to powder, it melts easily with borax and lime: when calcined it is considerably altered, loſes its colour and acquires weight. *Fabr.*

The beſt topazes are called *oriental*: they have the ſame properties as rubies and ſapphires, (Note s, § 76): and of courſe have the ſame properties, the colour excepted. They are found in Pegu, Ceylon, Arabia, Egypt, and Braſil, &c.

Thoſe called *occidental*, loſe their colour, transparency, and hardneſs in the fire. The topazes from Saxony, though they are as hard as the oriental, agree with the occidental in their other properties.

[c] The rock of Schneckenſtein in the valley of Danneberg in Voigtland, of the Upper-Saxony, is about 80 feet high, and about three times as much in its baſe: it is as hard as the topazes themſelves, and its powder is employed in poliſhing them.

But we have ſome topazes from Brazil, whoſe ſubſtance is widely different, as they do not loſe their transparency, nor hardneſs by fire: but even turn red like a fine ruby, and are ſold as ſuch (Note u. to § 76). Thoſe from Bohemia are in large priſms: their colour inclines to the hyacinth: and ſome are colourleſs, as ſome ſapphires are.

Tavernier ſpeaks of a very fine topaz belonging to the Mogul, of 157½ carats: and many others are known of a very large ſize.

The oriental topaz is valued by multiplying the ſquare of its weight in carats into 15 or 16 *ſhillings*; and the occidental one at the rate of 5 or 6 *ſhillings*. *Editor*, from Dutens, R. del' J. Bomare, &c.

- b. The

- b.* The yellow topaz from Schneckenstein.
- c.* Deep yellow, or gold coloured topaz, the oriental topaz.
- d.* Orange coloured topaz.

S E C T. 79. (46.)

The Chrysolite.

E. e. The yellowish green topaz, or chrysolite [*d*],

Is of a grass-green colour, and may belong to some other species, which might be discovered, if it could be obtained rough, or in its matrix, and large enough or in such quantity as is necessary for experiments to be made.

f. The

[*d*] The oriental Crysolite and Peridot are the very same gem. *Dut.* It becomes electric by being rubbed: its form is prismatic of 6 and sometimes of 5 striated faces. (*R. J.*). They are found in the East Indies, Brazil, Bohemia, Saxony, and Spain; in Bourbon and Auvergne in France; and in Derbyshire in England. Some are likewise found with volcanic lavas, as in the Vvarais, where some large lumps have been seen of 20 and 30 pounds weight. But it is remarkable that some of these chrysolites are partly decomposed into an argillaceous substance.

However, all chrysolites are far from being of the same kind: the *oriental* ones only differ on account of their green hue

f. The yellowish green and cloudy topaz, the Chrysoprase [e].

This

hue from those sapphires, topazes, and rubies of the same denomination. These do not lose their colour, or their transparency in the fire (*R. J.*): but the common chrysolite either becomes opake by a strong heat (*Berg.*); or is entirely fusible: and it phosphorises in the instant it melts, like the basis of allum and gypseous spar: with borax it produces a thin colourless glass. (*Fabr.*)

Its specific gravity is between 3.600 and 3.700 (*Fabr.*): according to Brissou, quoted by *R. J.* it is = 2.7821, or 2.6923: and that of the Spanish chrysolite = 3.0989.

Its substance is lamelated in the direction of the axis of its primitive form: but the chrysolite from Saxony is foliated in a perpendicular position to the same axis. *R. J.*

The chrysolite of the antients was the same gem, which is now called Topaz, and the name of itself indicates that it ought to be so. Pliny very plainly says (*B. 37. c. 9.*) that the colour of the chrysolite is *yellow like gold*. *Edit.*

[e] Mr. Achard has made the analysis of the Chrysoprase from Koseinitz in Silesia, which lost its colour, and transparency in the fire, becoming cracked and white in its surface, but without melting. Its powder, either with salt of tartar, mineral alkali, nitre, or borax gave a diaphanous glass: and with other substances produced opake masses of different colours.

The Chrysoprase is of a green colour, deeper than the Chrysolite, but with a yellowish tinge, inclining to blue, like the green leek, as Pliny says (*B. 37. c. 8.*). Mr. Achard says, that it never is found crystallised, and that it is semi-transparent. Mr. R. J. reckons it amongst the quartz, and says that its colour is owing to the mixture of cobalt, as it gives a fine blue glass when fused with borax, or with fixed alkali. But Mr. Achard found the glass of a *deep yellow* when the fusion was made with borax: and that it really contains some calx of copper instead of cobalt. Mr. *Dut.* says that some gold has been found in this kind of stone: but this last,
in

This is perhaps the substance which serves as a matrix to the chrysolite : for those I have seen of this kind are like the clear veined quartz, called in Swedish *Milk Crystal*, which is of the first degree of crystallization.

in all probability, belongs to some other class of substances, viz. to the vitreous spars.

The Aventurine in all probability is of this last kind : its colour in general is of a yellow-brown-red ; but sometimes it inclines more to the *yellow*, or the *green*, than to the *red* colour. They are not quite transparent : and some shine with such a brilliancy, that renders them of a considerable value ; but these are very rare. The common Aventurine is but an artificial glass of various colours, with which powder of gold has been mixed : these imitated Aventurines make very often a better appearance than the natural ones commonly do, and have lowered their esteem.

As to the Prase, its name from *πράσινον* shews it to be of a greenish-blue colour, like the leaves of a leek : it only differs from the chrysolite in its bluish hue. *Edit.*

S E C T. 80. (47.)

The Beryl.

F. Bluish green topaz, or the beryl.

This varies in its colours, and is called, when

1. Of a sea-green colour, the *aqua marina* [f].

2. When more green, the Beryl [g].

They are found in the stream-works in Saxony and Bohemia, in form of pebbles, or round pieces.

[f] The *aqua marina* found by Pallas in the mountain Adontscholo of Siberia, the *Peru emerald*, and the *chrysolite* from Brazil, are nearly the same, both in their form, and in their specific gravity (R. J.). This last of the Siberian *aqua marina* is 2,7213 (Briff.) It does not vitrify in the fire, but becomes opaque, and cracks in its surface. Sage, quoted by R. J.

The great Saxon mineralogist, and superintendant of the mines, M. Pabst von Oheim, who has a very instructive collection, likewise possesses such an octoedral *aqua marina*, on a piece of quartz druse from Shneckenstein, growing among some yellow topazes. It has no points, and the whole crystal has a flaw across the prism. Brun.

[g] The *beryl* and *aqua marina* are transparent, and of a green blue colour: some jewellers wrongly call them by the name of *oriental coralina*. They come from Ceylan, from the shores of Euphrates, from the neighbourhood of Mount Taurus, and from Brazil. Dut.

S E C T. 81. (48.)

The Emerald.

G. Emerald. *Lat.* Smaragdus gemma. *Swed.* and *Germ.* Smaragd. *Fr.* Émeraude [*b*].

Its chief colour is green, and it is transparent [*i*]. I believe it to be, or to have been, a crystal of its own separate principle, since in its qualities it differs both from the above-mentioned, and from the rock crystal [*k*]; but I cannot

[*b*] The Romans called it the *Neronian* or *Domitian gem*. (Waller.) The Persians and Indians call it *pachae*: and the Arabians *zamarrut*, from whence it is supposed the word *smaragdus* is derived. (Hill in his Notes to *Theophrastus*, pag. 61.)

The oriental emerald is a true sapphire of a green colour.
R. γ.

[*i*] The emeralds, in their rough or native state, consist of hexagonal columns, mostly truncated at both ends. I have samples of both transparent grass-green and light-green colours, which in a gentle heat become colourless; but white and opaque in a strong fire, without the least mark of any fusion.

When crystallised cockle or shirl is found of a green colour, transparent, and free from cracks or flaws, it is commonly called emerald by the jewellers, though it is generally of a deeper colour than the true emeralds, and also wants their lustre; and hence it is that the cockle-spar from Egypt is called the mother of emeralds. However, it may be, that this cockle was in antient times fashionable in Egypt, under the name of emerald, though now a days it is not so much valued as the emerald of this (siliceous) kind. *Eng.*

[*k*] The emerald, when heated to a white heat, becomes of a deep blue, and phosphorescent. It however recovers its
green

not positively assert this, since I know no more of it, than that it is the softest of precious stones [1], and that, when heated, it is phosphorescent like the fluors: and what in some cabinets is given out for its matrix, and said to come from Egypt, is nothing else than a deep

green colour when cold. When pulverised it becomes white: and melts with borax to a very thin colourless glass. *Waller.*

It becomes electric by being rubbed. *R. J.*

Its specific gravity is 2,700, or 2,800 according to Wallerius. Brisson makes it 2,7755: and Berg. from 2,780 to 3,711.

[1] 1. Pale green emerald,

Comes from the East, and from Peru; their figure is an hexagonal truncatted prism. Their basis is a vein of white quartz. The finest druse of this kind is to be seen at Loretto, in the treasure of the Holy Chapel, near Ancona, consisting of more than an hundred great and small emeralds. A fellow to it is made by art, and both are presents of the king of the two Sicilies, to represent two Mount Calvaries. *Brun.*

2. Dark green emerald, These

Are columnar, and striped longitudinally; their colour is very dark, and they are hardly transparent. The points are generally broken off, however Davila mentions one in form of a blunted triangular pyramid. There is one with a quinquagonal pyramid in the imperial cabinet at Vienna. Some of them, which must be selected by trials, have the properties of the tourmalin, (see § 85) of attracting ashes, when they are laid on burning coals, and acquire a certain degree of heat; but I never could discover that they repelled them again.

They do not attract so strongly as the tourmalin. The Prince of Noja, in his letter on the tourmalin, mentions the Brasilian emeralds among those hard stones, which when they are put into the fire, receive no electric power like the tourmalin: but he was possessed of, and tried such, as really had not that quality. The celebrated inspector of the Austrian mines, M. Jacquin, has been a witness of my experiments, *Brun.*

green cockle-spar [*m*], of which colour we likewise find cockle, or shirl, in the island of Uto, near Stockholm, and at Norbery, in the province of Westmanland.

Mr. Mailet informs us, that in former times the best emeralds were found in Egypt [*n*].

[*m*] The original Swedish has *skiorl spat*, that is, *cockle* or *shirl spar*, of which will be spoken hereafter; but the German translation terms it, *ein schoen spat*, a fine spar; that is to say (in this sense) a fine fluor. The schoerl or shirl of the Germans is a substance called by our Cornish miners *cockle*. D. C.

[*n*] Pliny mentions (B. 37. c. 5.) twelve kinds of emeralds: but, by his words, it clearly appears that many of these were different green stones, so called by the Antients. Theophrastus says (pag. 65 of Hill's edit.) that, in the records of the Egyptian kings, mention is made of an emerald 4 cubits long, and 3 broad: and of an obelisk composed of 4 emeralds, which was 40 cubits long, and from 4 to 2 cubits wide. Each *Egyptian cubit*, according to Pausan, is equal to $10 \frac{27}{1000}$ *French inches*, or near 11 English inches. If these and like accounts of large emeralds are to be depended upon, we must think they were some sparry fluors like those we have in Derbyshire, or some green glasses, like those manufactured in England, which are as beautiful, as the true emeralds: and of this kind seems to be, that large one kept in the Abbey of Reichenaw near the Lac of Constance, mentioned by Romé de l'Isle, pag. 246. vol. II. of his Crystallography, which measures above two feet and a half in length, &c. *The Edit.*

S E C T. 82. (Additional from a Note of Mr. Engestrom to § 49.)

The Hyacinth.

H. To the precious stones belong also the Jacinth, or Hyacinths, which are crystals harder than quartz crystals, transparent, of a fine reddish yellow colour, when in their full lustre [*o*] and formed in prisms pointed at both ends; these points are always regular, in regard to the number of the facets, being four on each point, but the facets seldom tally: the sides also, which form the main body, or column, are very uncertain, in regard both to their number and shape, for they are found of four, five, six, seven, and sometimes of eight sides; further, the column or prism is in some also so compressed, as almost to resemble the face of a spherical faceted garnet [*p*].

These

[*o*] The best Hyacinths come from Arabia, Calcut and Cambaya. They only differ in colour from rubies. *R. J.* and *Dut.* They are called oriental, when very hard and brilliant; and they are then reckoned among topazes: but when they are soft, they belong to the garnet kind: those from Compostella in Spain are of this last sort. *Wall.*

According to Dutens, the specific gravity of this gem is 2,631: but Romè de l'Isle says that Brisson found it to be 3,6873; and those of Europe 3,760.

[*p*] They are of a dodecaedral form like the garnet; but their angles are more obtuse. *R. J.*

These crystals lose their colour, become white, and do not melt in the fire; by which qualities chiefly they may be distinguished from garnets, (§ 84) which are likewise sometimes found of a colour not inferior to the true jacinths. The author had not, at the time when he wrote this Essay, seen the true jacinths, but mentions in Section 69, 2. c. that the reddish yellow garnets from Greenland are sold by the jewellers for jacinths; so are likewise the East Indian garnets of the same colour, and, what is still more, there are some jewellers that do not know the true distinctions between a jacinth and a garnet at all, but buy and sell the garnets for jacinths, when they are of a fine reddish yellow colour: this must in particular be owing to the scarcity of the true jacinth.

Mr. Cronstedt has since informed me by letter, that he had lately got some jacinths of a quadrangular figure, which did not melt in the fire, but only became colourless; this confirms what I have already mentioned about the jacinths I tried, and which are above described.

The *Jacinta la bella* of the Italians is a garnet of this yellowish hue: but when it is more of a reddish colour, it is then called *vermeille* by the French. *R. F. and Dut.*

The Chrysolestre is a yellow brown hyacinthe, like *honey*, or *amber*, but very distinct from the two above by being less hard, and by not having any electric power. *Dut.*

S E C T. 83. (Additional.)

The Amethyste.

I. The Amethyste is a gem of a violet colour, with great brilliancy, and as hard as the best kind of rubies or sapphires, from which it only differs by its colour. This is called the *oriental amethyste*; and is very rare: when it inclines to the purple, or rosy colour, it is more esteemed, than when it is nearer to the blue.

These amethystes have the same figure, hardness, specific gravity, and other qualities, as the best sapphires or rubies: and come from the same places, particularly from Persia, Arabia, Armenia and West-India. *Wall. Dut. Bom.* and *R. J. N. B.* This gem must not be confounded or mistaken, with the Syrian garnet. See § 84.

The amethystes called *occidental*, are of the same nature as rock crystals, and have the same gradations, viz. of a violet inclining to the purple or rosy colour, or inclining to the blue: very often they are semi-transparent without any colour in one end, and violet towards the other. The best are found in the Vic mountains of Catalonia in Spain, and at Wiesenthal in Saxony, as well as in Bohemia in Germany, in Italy, and in the province of Auvergne in France.

Cryftals within the geodes, or hollow agathe-balls, are very often found of an amethyft colour, and some are very fine. *R. 7.*

What we call now *amethyfte root*, or *mother of amethyft*, is but a fparry fluor, of which we have plenty in Derbyshire; many fine ornamental pieces are made of this fubftance in different forms and fshapes. Thefe fpars are found in infulated mafles, fometimes pretty large: but never in the form of large rocks. *Edit.*

S E C T. 84. (Additional.)

The Garnet.

K. The garnet. *Lat.* Granatus. *Swed.* Aecta or Klar Granat. *French,* Granat. *Germ.* Echter or Klarer Granat.

This ftone when transparent and of a fine colour is reckoned among the gems: but it varies more than any, both in the form of its cryftals and in its colour, fome being of a deep and dark red: fome yellowifh, and purplifh: and fome brown, blackifh, and quite opake. In general their luftre is lefs than that of other gems, as well as their hardnefs, which yields to the file although they may ftrike fire with fteel. But as to their form, thefe cryftals take almoft all forts of figures, as the rhomboidal, tetradcaedral, and fome are in an irregular form.

Their fpecific gravity according to Wallerius is from 3,600 to 3,900 and even to 4,400.

According

According to Briffon 4,100.

Those of Bohemia according to Cotes 4,360.

And those of Sweden according to the same author, 3,978.

Their colour proceeds from the iron which enters into their composition, and according to Mr. de Saussure even the finest oriental garnets attract the magnetic needle at a small distance.

The *Syrian garnet* is the finest and best esteemed. It is of a fine red inclining to the purple colour, very diaphanous, but less brilliant than the oriental amethyst. It seems to be the *amethystizontas* of Pliny: the Italians call it *rubino di rocca*, and is found in Syria, Calcutta, Cananor, Camboya, and Ethiopia.

The fine garnet of a red inclining to a yellow colour, is the *foranus* of the antients, the *vermeille* of the French; and the *giacinto guarnacino* of the Italians. Its name is taken from *Sorian*, or *Surian*, a capital town of Pegu, from whence these gems are brought: when they have a brownish taint, they are then called hyacinths.

The occidental garnet is of a deep and dark red, and its hardness is lesser. However, some very fine hard garnets are found in Bohemia. Garnets are found also in Hungary, at Pyrna in Silesia, at S. Sapho in the Canton of Berne, in Spain, and in Norway.

The garnet melts in the focus of a good burning glass into a brown mass, which is attracted by the load-stone, and this shows that iron enters considerably into its composition.

Some

Some garnets are found, which contain a little gold. Those called *zingraupen* by the Germans contain tin.

See Sect. 68 of the Author, where these garnetic substances are treated of at large.

It is probable that the *lapis alabandicus* of Pliny, book xxxvi. c. 8. which was black, and that other he mentions, of a deep purple (B. xxxvii. c. 7.) among the gems, were both true garnets. *Ed.*

S E C T. 85. (additional.)

L. Tourmalin. Ashdrawer. Tourmalinus, Lapis electricus. Trip in germ.

This is a kind of hard stone, lately brought into notice by its electrical properties [*q*].

1. Its form is a prism of nine sides of different breadth, mostly truncated, and seldom terminating in a pyramid at each end, which is
either

[*q*] This stone has been known in Europe since the year 1717 only, in which year Lemery first shewed it in the Royal Academy of Sciences at Paris. Since that time it has been made more known; and the Dutch have spread it every where. Most of them are flat on one side, and convex and polished on the other. There are, however, likewise some rough ones like pebbles. Most of them are transparent: and the Prince de Noja, in his letter to Count Buffon, affirms, that he likewise had an opaque one. The largest I ever saw is in the cabinet of Mr. Steiglitz at Leipzig: its size is nearly a square inch, and its thickness two lines. Besides this size, it has a very remarkable quality. When you look through the two largest surfaces, which are but two lines
asunder,

either composed of three pentagons, or of nine triangles.

2. When heated in the fire, it gives signs of contrary electricity on the two opposite ends of their prismatic form [r]. But many of these

afunder, it appears wholly opaque; but covering these, and looking through the small surfaces which are near 12 lines afunder, it is quite pellucid: which must necessarily arise from the peculiar texture of the stone. It is only flat on one side. We know nothing of the spot where the Tourmalin is generated. Aepin and Bergman have written the latest dissertations upon it, and mentioned all its electric qualities. Dr. Pallas, from whom we are now to expect great elucidations on the natural history of Siberia, shewed me a Tourmalin, which was perfectly like the others in colour, hardness, and transparency, but would not draw ashes. Wilson affirms, that when a tourmalin is made red hot, and kept in a violent fire for half an hour, it does not lose its colour; and if it is cooled of a sudden in water, it loses its electric quality for ever. *Brunnich.*

[r] Some speak of *poles of electricity* in these stones (See R. del. J.) meaning that the power of electricity is the stronger in the middle axis of the two opposite parts of their prismatic form. This seems to be rather an awkward expression for conveying that idea! Others speak of a certain phosphoric *corruscation* in the moment of its fusion by a strong heat: as if there would be wanting any *phosphoric* power or quality to shine of a sudden in the very moment of its fusion, in which the outside parts pass into an even ignited state! In the cupellation of gold and silver, the corruscation, or *éclair* as the French call it, appears in the very moment that all heterogeneous particles of the alloy are gone off; and this becomes more remarkable, because the purified metal fixes itself immediately after; on account of wanting a higher degree of heat to be kept then in fusion, than whilst it was mixed with the other metal of the alloy. N. B. Professor Bergman found several opaque schoerls of Sweden to possess the same electric qualities of the Tourmaline; but could not find any pellucid ones with the same property. *The Editor.*

stones

stones are not in the least electric. However, on being rubbed, they become electric in their sides, like other diaphanous gems.

3. They are as hard almost as the topaz, and strike fire with steel.

4. They melt by themselves in a strong fire, though with difficulty.

5. With the microcosmic salt they melt perfectly; but only in part with borax.

6. With mineral alkali, they are divided into a kind of powder.

7. The three mineral acids dissolve them, when first reduced to a powder.

8. They bear a greater similarity to schoerls, than to any other stone: but their component parts shew that they may be ranged with propriety in this place, along with other precious stones: as the argillaceous earth is also the most prevalent in their composition.

a. The oriental Tourmalines are found in the island of Ceylon. They are transparent, of a dark brown yellow: and their specific gravity is from 3,062 to 3,295.

b. From Brasil. Transparent. These are green, for the most part; but there are also some red, blue, and yellow: their specific gravity is from 3,075 to 3,180.

c. From Tyrol. Of so dark a green as to appear opaque. Their specific gravity is about 3050. These are found in beds of steatites, and lapis-ollaris amongst the micaceous veins, talcs, and hornblende of Schneeberg,

Schneeberg, Jurzagl, and Zillerthal, in the mountains of Tyrol. *The Editor.*

- d. From the mountains of Old Castile in Spain. These are transparent, and have the same properties as the preceding ones. *The Editor*, from *Bergman, Muller, Fabroni, Romé de l'Isle, and de Launay*. N. B. According to this last able mineralogist, the Tourmalin has been already ranged among the precious stones in the Copenhagen edition of Cronstedt, in 1770.

S E C T. 86. (55.)

M. The Opal. *Opalus. Paedros Græcorum*[s], the *Girafole* of the Italians.

It is the most beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and must therefore be described under both these circumstances [t].

- a. The Opal of Nonnius, the Sangenon of the Indians.

This appears olive-coloured by reflection, and seems then to be opaque, but when held

[s] Wallerius calls this precious stone the *Paederos Plinii*, which must be understood of what he mentions in his book, 37. c. 6. but the same naturalist, Pliny, gives also this name to a different stone, as appears by the chap. 9. of the same book, 37, where he says *Candidarum dux est Paederos*, mentioning a less valuable gem, *plebeiam gemmam*. The Edit.

[t] It loses its colour and transparency in fire; and in other respects is affected by it as a quartz or flint.

It fuses with borax though difficultly.

Its specific gravity is 1.900. and upwards. *Fabr. ex Waller.*

against the light, is found transparent, and of a fine ruby red colour.

That opal is supposed to have been of this kind, which Pliny mentions in his *Natural History*, book 37, chap. 6. and which he says, was in the Senator Nonius's possession, who rather suffered banishment than part with it to Anthony.

This stone was in Rome at that time valued at 20000 sesterces [*u*]. The stone here particularly described, was found in the ruins of Alexandria; it is about the size of a hazle-nut, and was bought for a trifle of a French drogoman [*x*] named Roboly, and presented to the French general Consul Lironcourt, who afterwards offered it to sale in several places for the sum of 40,000 rixdollars. See Hasselquist's Travels to the East, under the article Opal [*y*].

There

[*u*] According to Paucet (in his *Metrologie*, p. 433,) twenty thousand sesterces were worth 4500 *French livres*, or 187 *Louis and a half*. It is remarkable that the same author has asserted at page 398, that the value of 20000 sesterces is only 3906 *French livres*, which hardly amounts to 163 *guineas*. I could wish this contradiction might rather be attributed to an error of the press, or to my own mistake, than that so useful a book should be blotted with such errors. *The Edit.*

[*x*] That is to say *Interpreter* and *Broker* in Turkey. *Wern.*

[*y*] This very stone was in the year 1763, in the possession of his Excellency the Duke de Nivernois, then ambassador to the British Court. D. C.

However, Wallerius thinks, that this opal found in Alexandria, was not that of Nonius, mentioned by Pliny; and adds, that it was supposed by many to be no more than a counterfeit

There is, however, another of the same kind in Sweden, which by reflection appears rather brown; but by refraction it is red with violet veins.

b. The white opal. Its ground is white of a glass-like complexion, from whence are thrown out green, yellow, purple, and bluish rays; but it is of a reddish or rather flame-colour, when held against the light.

1. Of many colours. The oriental opal [*z*].
2. Of a milkey colour [*a*]. From Eibensstock in Saxony.

3. Bluish

feit of fine glass, or paste. Indeed the same Pliny, in the above quoted chap. 6. B. 37. asserts, that glassy compositions were made in India quite similar to true opals: but adds, that they might be distinguished from one another by exposing both to the solar rays between the fingers, the true opals transmitting and throwing the light in different groupes and directions, whilst the artificial ones only transmitted it with an uniform colour. Pliny might as well have added another more certain test, viz. that of trying their hardness by a hard file. It is a pity that no mention is made of the above Duke's opal being ever tried by these two tests. Perhaps the owner did not wish to clear up the matter. *The Edit.*

[*z*] Wallerius, in his Mineralogy, (Ed. 1778) says, that this white opal answers much better the description given of it by Pliny, than the olive-coloured one, asserted by Cronstedt: and there is no doubt but by an attentive perusal of the original of Pliny, one cannot fail of preferring the opinion of Wallerius.

As to the irregular compartments of various colours which distinguish this kind of precious stones, they are well accounted for in the manner explained in the first Note to the following Section. *The Editor.*

[*a*] I have lately obtained a small piece of pseudo-agate, from the East Indies, which is of a yellowish brown, and pale blue, or rather milk colour, with a shining brightness, exactly
like

3. Bluish; and semi-transparent. This is not so much valued as those which are more opake; because it is easier to be imitated by art [b].

SECT.

like that of the milky opals of this section, and received also some other specimens found at St. Georgio, near Turin in Piedmont, there called by the name of Pseudo-agates (Bastard agates), a name which seems very well adapted to this stone; since in every respect, hardness excepted, it comes nearest to the agates; because, 1. It is transparent in the same degree as agates, and varied with red and grey colours, interspersed sometimes with white opaque veins, or rings, and black dendritical figures. 2. It is of a very fine and shining texture; when broke, rather superior to those of the agates, but so soft that it scarce yields any sparks when struck against steel; and does not admit of any polish but what is inferior to the lustre of its natural texture: however, it slightly marks common window glass. 3. When broke through the dendrites, it is as smooth and shining at that place as in any other; and these dendrites vanish in the fire, without leaving any pores in the stone. 4. It does not melt before the flame, by the blow-pipe, but becomes perfectly white and opaque. 5. Nor is it fusible even with borax. 6. It does not ferment with the acid of nitre.

Sometimes this stone is surrounded with a white crust, like common flints in the strata of chalk, which crust has likewise the same effect as that of the flint, when this last mentioned has been previously freed from the adherent chalk; viz. 1. It does not dissolve in the acid of nitre. 2. it is not fusible by itself in the fire. 3. But melts pretty easily with borax, though without any effervescence, contrary to what we observe with calcareous substances; and thus borax will dissolve a quantity equal to about three quarters of its own bulk, though not without difficulty, especially towards the end of the operation; but the glass becomes quite clear and colourless, instead of growing white and opake, as with calcareous substances. *Engest.*

[b] Not only this, but also some of the other kinds of opals have been well imitated by art, there being found compositions

S E C T. 87. (49.)

Observations on the preceding bodies, called precious stones, or gems.

I have before mentioned the reasons, why I give these their separate places from the following stones, among which they might else have been ranked, as they are already in other systems: to which I will venture to add, that, as a naturalist, I cannot conquer that ge-

positions of glass, which shew very different colours by refraction from what appear by reflection. A curious ancient one of this kind is to be seen in the royal abbey of St. Dennis, near Paris, which is green on the outside, and shews a fine ruby colour, when viewed against the light. I have seen also glass-pastes, some made in London, by Edward Delaval, Esq; F. R. S. and some others by Mr. More, Secretary to the Society of Arts, which appeared of a yellow-brown, or other colour by reflection: but when held against the light, transmitted a fine blue, or a purple, and red colour, like the *sapphires, rubies, garnets, hyacinths, &c.* Wallerius points out the proper ingredients to make these pastes: and I found by chance that the *red glass* of Kunkel (whose composition may be seen in *Journal de Physique* Suppl. to 1782), being overmelted or burned in a common fire, produces the like effect, transmitting a colour by refraction, and a different one by reflection. But the fine imitation of the true white opals, made by the Indians and mentioned by Pliny in the above quoted passage of his Book 37 C. 6. never were produced, as far as I know, by the moderns. *The Edit.*

neral weakness of valuing them so highly; for besides their surprising hardness, and fine colours, that please the eye, it is not without foundation, that they might be thought applicable to every use for which the siliceous kind is employed, if they were to be had in large quantities: and by that alone it is that they deserve to have the preference of the other stones of this order [c].

In regard to their colours, it is to be observed, that those of the ruby and emerald are said to remain in the fire, but that the colour of the topaz flies off: whence it is usual to burn that

[[c] The transparency and crystallized forms of gems may be added as a further motive for treating of them before the other kinds of hard stones: but as to their constituent parts, late experiments have shewn that for the most part it is the *argillaceous* and not the *siliceous* earth, which has the greater share in their composition, as will be seen in the Table annexed to the note in page 165. But even this will scarcely be a sufficient reason for classing them in the argillaceous order of earths; if it be true that they owe their extreme hardness to the portion of silex, which enters into their composition.

All gems and crystals are observed to be of a foliated or laminated structure, and of various degrees of hardness. Whenever the edges of these laminae are sensible to the eye, they have a fibrous appearance, and reflect variegated shades of colours, which change successively according to their angular position to the eye. These are called *chatoiantes* by the French: and what is a blemish in the point of transparency, often enhances their value on account of their scarcity. But when the substance of a gem is composed of a broken texture, consisting of various clusters or sets of laminae differently inclined to each other, it emits at the same time various irradiations of different colours, which succeed one another according to their angle of position. This kind of gems are called Opals, which are valued in proportion to the brilliancy, beauty, and variety of their colours. Edit.

gem on purpose that it may be made use of instead of the diamond, as it is harder than the quartz crystal[*]. The colours of gems are commonly supposed to depend on metallic vapours: but may they not more justly be imagined to arise from a phlogiston, united with a little metallic or some other earths? because we find that metallic earths, which are perfectly well calcined, give no colour to any glass, and that the manganese, on the other hand, gives more colour than can be ascribed to the small quantity of metal which is to be extracted from it[b].

The phlogiston may perhaps have more difficulty to escape through the pores of the hardest of the precious stones, if it is true that the property of losing the colour is in proportion to their hardness, as some authors seem to indicate, by assuring us, that none but the coloured diamonds and the rubies keep their colours in the fire; but in this circumstance I likewise want experience, but hope to see it illustrated by

[a*] This is a mistake. See note [u] to Sect. 76. The Author meant the Sapphire. *Edit.*

[b] As to the various colours of gems, no doubt, they proceed chiefly from the mixture of iron which enters into their composition, as appears by the results of repeated analysis of them, which are exposed in the table at the end of the following Note. The hint given by the noble author in the text of this section, viz. that their colours may arise from the phlogiston united with some metallic earth, evinces the superiority of his judgment and great sagacity in mineralogical matters: for it is now well known that calces of iron when dephlogisticated produce the red or yellow colour of marbles, and when it is phlogisticated to a certain degree, it produces the blue and green colours. See § 47. pag. 81. The Editor.

those who may happen to get an opportunity of discovering the true methods to deliver the world from the many ambiguities and distinctions, which have been made on this subject, and which perhaps are all formed upon as great reason, as those we still use in distinguishing the *oriental* and *occidental* gems, which signifies in other words no more than *hard* and *clear*, or *soft* and *flawy*, *deeper* or *paler*, or of *good* or *bad* colours [*a*].

[*a*] The crystallization of gems deserves to be taken notice of in this place. No doubt but it depends on the same cause which produces that of *salts*, *earths*, and *metals*, and which we are unable to express in any other way but by the mutual attraction of the component parts that constitute each mass. It is highly probable that the most minute molecules, or *stamina*, of each kind of crystals are possessed of a determinate angular figure, endowed with respective powers of attraction, from which arises the aggregation of each compound. Sir Torbern Bergman has written a very valuable treatise on this subject, which the reader may consult for his satisfaction.

But as to the particular configuration of each species of gems, we can hardly depend upon any individual form, as a criterion to ascertain each kind: and when we have attended with the utmost care to whatever Mr. Romé del'Isle has written with singular industry on this subject, in the 4 large volumes 8vo. of his *Cristallographie*, we must at last appeal to the chemical analysis of each substance; because it very often assumes various forms. These trials and chemical processes must require not only much ingenuity and practical knowledge, but also a very considerable expence, on account of the dearness of these precious substances: but their results would not probably extend our knowledge much beyond what we already know, by the great skill, accuracy, and indefatigable labours of the above celebrated Professor of Upsal, and of the ingenious Mr. Achard of Berlin, to whose names we may add those of Scheel, Morveau, Darcet, and Bayen.

S E C T. 88. (50.)

Quartz, in general.

Quartz. *Quartzum.*

This stone is very common in Europe, and easier to be known than described. It is distin-

In the following table of the component parts of gems, the letter *B* is prefixed to the analysis of Bergman, and *A* to that of Achard.

		Argillaceous.	Silic.	Calcareous.	Iron.
Red ruby oriental	B.	40	39	9	10
Ditto	A.	37,5	42,5	9	11
Blue sapphire orient.	B.	58	35	5	2
Ditto	A.	58	33	6	3
Yellow topaz from Saxony	B.	46	39	8	6
Green emerald orient.	B.	60	24	8	6
Ditto	A.	60	23	10	7
Yellow brown Hyacinth orient.	B.	40	25	20	13
Ditto	A.	42	22	20	16
Tourmallin from Ceylon	B.	39	37	15	9
Ditto from Brasil	B.	50	34	11	5
Ditto from Tyrol	B.	42	40	12	6
Garnet from Bohemia	A.	30	48	11	10
Chrysoptase from Koseinitz in Silesia		Magnesia.		Copper.	
	A.	0	1½	94½	2½ 1 ½

Mr. Achard, who made the analysis of the Chrysoptase from Koseinitz in Silesia found it to contain 456 grains of siliceous earth; 8 of calcareous earth; 5 of sparry fluor's earth (which is the true calcareous earth, and makes 13 grains of this last); 6 grains of magnesian earth; 3 of copper; and 2 grains of iron: which numbers were reduced like those of the Table. This seems to be the only gem which contains no argillaceous earth. *Edit.*

guished from the other kinds of the siliceous order, by the following qualities.

1. That it is most generally cracked throughout, even in the rock itself. Whereby,
2. As well as by its own nature, it breaks irregularly, and into sharp fragments.
3. That it cannot be easily made red hot without cracking still more.
4. It never decays in the air.
5. Melted with potashes in a due proportion, it gives a more solid and fixed glass than any other of the siliceous order.
6. When there has been no interruption in its natural accretion, its substance always crystalizes into hexagonal prisms, pointed at both ends.
7. It occurs in clefts, fissures, and small veins in rocks. It very seldom forms large veins, and still seldomer whole mountains, without being mixed with heterogeneous substances [*f*].

[*f*] Quartz neither loses its hardness nor its weight, by calcination. Its texture is lamellar. These stones are in general the purest of the siliceous genus, though most contain a slight mixture of other earths: the most obvious distinction among them arises from their transparency or opacity. *Edit.* from *Kirvan*, &c.

S E C T. 89. (51.)

The Quartz is found, 1. Pure, *Quartzum purum*.

A. Solid, of no visible particles, with a glossy surface. *Particulis impalpabilibus superficie polita.* Fat Quartz.

a. Transparent and colourless, *Diaphanum*, Is found in the copper mines in the north part of Norway and in Siberia. This has no cristallized form, but is nevertheless as clear as quartz cristals of the best water.

b. White, the common fat quartz.

c. Blue, from the island of Utto, in the province of Smoland.

d. Violet, from the island of Uto.

B. Grained. *Textura granulata*, Dry Quartz.

a. White from the gold mines at Adelfors in the province of Sodermanland, and the copper mines at Louisberg in Westmanland.

b. Pale green, from Adelfors.

C. Sparry quartz. *Textura Spatosa*.

This is the scarcest, and ought not to be confounded with the White Felt-Spat; because it is of a smoother appearance, and breaks into larger and more irregular planes.

- a. Whitish yellow, from the Gold Mines in Hungary.
- b. White, from the Island of Uto [g.]

S E C T. 90. (52.)

D. Crystallized Quartz. *Quartzum Crystallifatum*. Rock Crystal. Quartz Crystal. *Crystallus Montana* [b].

Its

[g] The Hungarian gold and silver veins near Hoderitch, which are often some fathoms wide, afford this lamelated and porous quartz. There are *white*, *yellow*, and *blue* sorts of it; and sometimes it is finely crystallized in pyramidical figures. I have not found this species any where else in Hungary, unless at Stolberg, where some of the veins have a little of it, *Brun*.

[b] When great quantities of quartz are continually agitated by the falls and motions of river and sea water, they are reduced sometimes to such very minute parts as to be easily carried away, suspended in the water: and there are sands of so minute a size as to measure less than the *two* or *three* hundredth part of an inch. These are called *Quick Sands*. Immense tracts of land consist only of loose sand, and particularly along the sea shore in many parts of Europe. Some pretend that sea water has the power of producing this sand out of its component parts, and their surfaces for the most part are so polished as to shew that they could not be reduced in size by rubbing against each other: but we know not as yet that such a production has ever been demonstrated. When sand is about as big as common *peas*, it is called *gravel*: and when it is free from saline and heterogeneous particles, it is employed in making mortar, and in other economical purposes. That which

Its figure is already described (Sec. 88. N^o 6.) and in regard to its colours, the following varieties occur.

1. Opaque, or semi-transparent, *crystallum opacum, vel semi-diaphanum*.
 - a. White, or of a milk colour.
 - b. Red, or of a carnelian colour, from Oran in Barbary.
 - c. Black, from the same place.
2. Clear, *diaphanus* [1].
 - a. Blackish brown [k], smoaky Topaz, or the *Rauch Topaz* of the Germans, is found at Egern in Norway, and at Lovisa in Finland.
 - b. Yellow, found in Bohemia, and sold instead of topazes.
 - c. Violet, the Amethyst, from Saxony, Bohemia, and Dannemore in Upland [l].
 - d. Co-

which is very pure serves for making *flint glass*, with red calces of lead and the proper alkaline flux: but when it has some mixture of the ferrugineous black sand, the glass becomes of a greenish black colour. This I have seen among the various specimens of glass, made by Mr. E. Delaval, F. R. S., who produced a very fine transparent and colourless glass, out of the same sand with which he had made some of that black glass: and this only by separating from it all the ferruginous mixture. *The Edit.*

[1] Its specific gravity is from 2650 to 2700. Professor Bergman has extracted from these crystals about six parts of *Argilla*, and one of *calcareous earth*, per hundred weight: but Mr. Gerhard found some so pure as to contain neither. *Kirw.*

[k] It is said that brown crystals are cleared by boiling them in tallow. 7 Roz. 360. quoted by Kirwan.

[l] The most transparent are called *false diamonds*, *Bristol*, *Kerry stones*, and *Alençon diamonds*, &c. The coloured transparent

d. Colourless rock crystal, properly so called, from Bohemia: also from the province of Jemtland, and many other places; when these coloured crystals are not clear, they are called Flufs, for instance *Topaz-flufs*, *Ametbyst-flufs*, &c. &c. [m].

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parent crystals derive their tinge generally from metallic calces, though in exceeding small portions: they all lose their colours when strongly heated. These are what we call false gems, viz.

The red, from Oran in Barbary, *false rubies*.

The yellow, from Saxony, *false Topazes*.

The green, from Dauphiny, (very rare) *false emeralds*, or *prases*.

The violet, from Vil, in Catalonia, *false amethysts*.

The blue, from Puy in Valay, France, *false sapphires*.

There are also *opal*, or *rainbow crystals*, some of which make a very fine appearance, the various colours of which are thrown out in zones across the surface, though they never shine like the Oriental opal. Edit. from Mongez, in his Notes to Bergman's *Sciagraphia*, and from Kirwan.

[m] e. Pyramidal crystal, with one or two points.

These have no prismatic shape; they either stand upon a base in cavities of quartz veins, have only a single pyramid, and are of various colours; or they lie in a clayey earth, and have both pyramids but no prism. Found at Blackenburg upon the Hartz, and at Morserosh in the Silverland in Transylvania. Of this I have only seen colourless transparent ones. *Brun.*

Mr. Fourcroy makes a remarkable difference between the crystals and the quartz, by affirming that the former are unalterable in the fire, in which they neither lose their hardness, transparency, nor colour, whilst the quartz loses the same qualities, and is reduced by it to a white and opaque earth. The same author classes the rock crystals,

1st, According to their form, viz. 1. Insulated-hexagonal crystals, ending in two pyramids of six faces, which have a double

S E C T. 91. (53.)

E. Impure quartz. *Quartzum heterogeneis intime mixtum.*

A. Mixed with iron in form of a black calx. *Quartzum calce ferri atra intrinsece mixtum.*

This is black, of a glossy texture, and contains a great quantity of iron.

It is found at Staf's iron mine in Sodermanland, and at Gierdesiostrand in the parish of Offerdal in Jemtland, at which last place the iron also discovers itself by its rust in the cracks of the stone.

double refraction, or shew two images of the same object when looked through. 2. Hexagonal crystals united, having one or two points. 3. Tetraedral, dodecaedral, slated crystals, and which, though hexagonal, have nevertheless their planes irregular. 4. Crystals in large masses, from the island of Madagascar, which have a simple refraction.

2dly. As to the colour they are either diaphanous, reddish, smoakey, or blackish.

3dly. As to accidental changes, some are *hollow*: some contain *water* within one or more cavities: some are cased, viz. one within the other: some are of a round form, as the pebbles of the Rhine: some have a crust of metallic calces, or of a pyrites: some are of a geodical form, viz. crystallized in the inside of a cavity: some seem to contain amianthe, or asbestos, and others contain shirls.

The same author reckons among crystals, the oriental topaz, the hyacinth, the oriental saphire, and the amethyst. Mr. Daubenton has always looked on this last, as a quartzous crystal. *Edit.*

B. Mixed

B. Mixed with copper in form of a red calx.

Quartzum croco veneris mixtum.

Red. It is found in Sunnerskog's copper mine in the province of Smoland.

SECT. 92. (From a Note of the Author.)

Observations on Quartz and Rock Crystals.

That the colour of quartz depends on metals, is easily proved by metallurgical essays, and the resemblance they have with compositions of glass, made on the same principle; but the same cannot be asserted of the precedent coloured quartz (89, 90) before it be evidently demonstrated.

It is very likely, that a quartz may be found which is intimately mixed with a calcareous earth, and such is, perhaps, the Hungarian sparry quartz (89.) Which, however, I recommend for further examination.

The quartz in general, and especially its crystals, are very commonly thought, when yet in their soft or dissolved state, to have included within them some vegetables, for instance, grass and moss. This I cannot absolutely deny; but I must at the same time observe, that it deserves carefully to be examined, if that which is shewn as a grass be not an asbestos, or a striated cockle; and the moss, only branched vacuities

vacuities filled with earth, which, by their being ramose, bear a vegetable appearance: it is very common in agates, and makes them of less value than otherwise they would be; this is most generally the case with those stones which are shewn as including vegetables, and for my own part I have never been so fortunate as to meet with any others.

When the rock crystals are semi-transparent, or intermixed with opaque veins, they are by the Swedish lapidaries, called *milk crystals*. When they are found in form of round pebbles, which is occasioned by their being tossed about and rubbed against one another by floods, or by the sea, they are called by the English lapidaries, *pebble crystals*. They come from the Indies, Siberia, and other places, but these cannot be ranged separately, for reasons which will either readily occur, or are already mentioned in their proper places [n].

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[n] Quartz is one of the principal kinds of stone which contain metals. Some of the Hungarian veins consist entirely of it, and the gold is so minutely dispersed in it, as not to be discernible by the best microscopes, before it is separated by pounding and washing. The width of the veins, some of which are half a fathom wide, and sometimes open still wider, repay the pains and expences, which the small quantity of gold contained in it could not otherwise counterbalance. Nature has doubtless no where produced mountains of pure quartz; for the rocks at Obersihona and Freudenstein in Saxony, though they are reckoned among quartzes, according to their exterior character, seem to have more constituent parts of different nature. Near Lauterberg upon the Hartz
are

S E C T. 93. (54.)

F. The flint. *Silex pyromachus*. *Lapis cornéus*, or the *hornstein* of the Germans.

are quartz veins, from one to three fathoms and upwards wide, consisting of a loose sand, in which they find the copper ore in nests.

The triangular quartz pebbles of the Danish isle of Anhalt, likewise deserve to be mentioned. Borrichius, in the Act. Hanf. vol. IV. p. 177, has mentioned them: and they are still found to this day. There are likewise quartz crystals, in which drops of water are inclosed. The imperial cabinet at Vienna, and several other cabinets, have some fine pieces of this kind. *Brun.*

Mr. Fourcroy mentions the 7 following species of quartz, viz. 1. Transparent, crystallised in two hexagonal pyramids joined at their bases without any intermediate prism, or at least with a very short one. 2. Those which are in one transparent mass. 3. The opaque or of a milky colour. 4. Those which look fat or greasy. 5. Decayed quartz. 6. Those of amethyst colour. 7. And finally, those of a lamelated texture when broken. He reckons the Brazilian and Saxon topazes among the quartz. See the difference asserted by this author between the crystals and quartz in the Note *m* to the Section 90.

Rock-crystals are generally formed upon or among quartz, which shows their great affinity: and are to be found in all parts of the world. Mount Saint Gothard in Switzerland has furnished the greatest quantity to Europe. Large pieces of these crystals weighing from 5 to 800 pounds were found there at Grimselberg: another of about 1200 pounds weight was found some years ago at Fribach in the Wallais: and a large piece 6 feet long four wide and equally thick, was found in the island of Madagascar, a place where these natural productions are of the most extraordinary size and perfection. *The Editor from Bomare, &c.*

This is equally common with the quartz, and it is full as difficult to describe it; especially as it forms a kind of intermediate substance between quartz and jasper, both which it so nearly resembles, that it is not easy to point out such characters as shall readily distinguish it from them. The best way, perhaps, will be to speak of its properties comparatively; and then we may say that,

1. It is more uniformly solid, and not so much cracked in the mass as the quartz; and,
2. It is more pellucid than the jasper.
3. It bears being exposed to the air, without decaying, better than the jasper, but not so well as the quartz.
4. It is better for making of glass than the jasper, but is not quite so good as quartz for that purpose.
5. Whenever there has been an opportunity in this matter of its shooting into crystals, quartz crystals are always found in it; just as if the quartz made one of its constituent parts, and had in certain circumstances been squeezed out of it: this is to be seen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often shews most evident marks of having been originally in a soft and slimy tough state like glue or jelly [o].

[o] 7. When broken it is scaly, generally unequal, and cracks into thin lamellae. *Brun.*

8. In a calcining heat they become opaque-white and milky. *F.*

The several varieties of this species have obtained more distinct names with respect to their colours, than from any real difference in their substance; but these are still necessary to be retained, as the only names used by Jewellers and others, who know how to value them accordingly.

S E C T. 94. (Additional.)

Jade. *Lapis nephriticus, jaspachates.*

The true lapis nephriticus seems to belong to this siliceous order; as it gives fire with steel, and is semi-pellucid like flint; it does not harden in fire, but melts by the solar heat in the focus of a burning lens, into a transparent green glass with some bubbles. That called by the name of *circumcision stone*, which comes from the Amazon-river, melts easier, in the same solar fire, into a brown opaque glass, which is far less hard than the stone itself.

Macquer.

This stone is superior in hardness to quartz, though from its unctuousity to the touch, one would suspect it to contain a large portion of argillaceous earth, or rather of magnesian earth, as Mr. Kirwan seems to suspect.

Its specific gravity is from 2,970 to 3,389. It is of a granular texture, of a greasy look, and exceedingly hard: is scarcely soluble in acids,

at least without particular management, and is infusible in the fire. Mr. Saussure seems to have extracted iron from it.

- a. It is sometimes of a whitish milky colour, from China; but mostly
- b. Of a greenish, or
- c. Deep green colour, from America.
- d. Grey, yellowish, and olive colour: these are the vulgar *lapis nephriticus*, they being supposed to cure the nephritic pains by their external application to the loins.

The semi-pellucidity, hardness and specific gravity are the characters by which the lapis nephriticus may be distinguished from other stones. *Kirwan, Fabr. and Mongez.*

S E C T. 95. (56.)

The Cats eye. *Pseudopalus*. (The Sun-stone of the Turks, called *Guneche*, according to *Bom.* *Oeil-de-Chat* in *French*.)

This stone is opaque, and reflects green and yellowish rays from its surface: it is found in Siberia [p].

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[p] It is very hard and semitransparent, and has different points from which light is reflected with a kind of yellow-brown radiation somewhat similar to the eyes of cats, from whence it had its name. Jewellers do not fail to cut them round to the greatest advantage. The best of these stones are very scarce. One of these of one inch diameter was in the cabinet of the Grand Duke of Tuscany. *Bomars.*

S E C T. 96. (Additional.)

Hydrophanes, or *Oculus Mundi*. Also called *Lapis Mutabilis*.

This stone, which was formerly of great value, but little known to the moderns before Mr. Boyle had made it the subject of his observations, is commonly of a whitish brown colour, and not transparent. It is insoluble in acids, and is not affected by alkalis. Its specific gravity is about 2,048.

Professor Bergman has made the analysis of the Eibenstock-opal, which is a kind of *Cat's-eye*, and found nearly the same results as those of the Chalcedony from Feroe. It contains above 84 hundredth parts of siliceous earth, and less than 16 hundredth of argillaceous earth. This stone may be considered as a purer kind of Chalcedony, but it is too soft to strike fire. Its specific gravity is from 1958 to 2075, according to the same Professor: however, Mr. Kirwan allows to it a specific gravity from 1700 to 2240. The usual fluxes act on it as on flints. *Edit.*

See Note c. to pag. 162, about those stones which reflect various colours successively, as their position is changed in regard to the eyes: and Note a to Sect. 86, pag. 159, where a kind of pseudo-opal is described by Mr. Engestrom. N. B. Some Quartz have also the same property. See Note l. to Sect. 90.

The common *Girafsole* of the Italians, and that stone called by the name of *IRIS*, only differ from these pseudo-opals in the variety of colours they reflect: the *Iris* appearing of a *reddish brown*, upon which the rays of the sun make the appearance of the *rainbow*: but there are various other stones which have the same appearance when exposed to the sunshine.

As to the common *Girafsole*, it appears by the description of Mr. Dutens to be nothing else but the *Moon-stone* of Sect. 99. in which a kind of *yellow* is seen intermixed with its *bluish-milk-white* colour. *Edit.*

It

It is easily cut and polished.

It sometimes gives fire with steel, and sometimes not. It is infusible *per se*; but, being urged by the blow-pipe, it changes to a brown brittle substance.

The principal property which distinguishes it from all other stones, is that it becomes transparent by mere infusion, in any aqueous fluid; but it gradually resumes its opacity when dry [q].

It is found in beds more or less thick over the opals in Hungary, Silesia, and Saxony: and over the chalcedonies and agates in Iceland. These stones are either of a yellowish green, or of a milky grey, or of a yellow, like that of amber. *F.*

[q] There are in the British Museum at London, three of these stones called *Oculus Mundi*. The largest of them is about the bigness of a cherry-stone, though in an oval form. It is opaque, and its colour like that of a common yellow pea; it may be scratched, though not without difficulty, by a knife; it seems however to leave a mark on common glass, and does not ferment with the acid of nitre.

When it has lain in water some hours, it becomes transparent, and of a yellow amber colour. This change begins soon after the immersion, and at one end, in form of a little spot, (but in a small one of the same kind the beginning is round the edges) which increases by slow degrees until the whole stone is become uniformly clear throughout: when taken out of the water, it loses its transparency, first at one end, and then gradually over the remainder, until the whole stone has recovered its former opacity; and this change happens in less time than that of its becoming transparent. *Engestr.*

The hydrophanes in general belongs to the siliceous kind. But some steatites have the same quality, as Bergman affirms: and the crust of Chalcedonies and Agates produce often the same appearance. *Edit.*

S E C T. 97. (Additional.)

Observations on the *oculus mundi*.

This stone has been long admired, though very little pains have been taken to know from whence it comes, or what the nature of it is. It is to Mess. Bruckman and Veltheim that we owe the knowledge of its origin, or at least the mineral in which it is found, besides several of its properties equally unknown before.

As soon as this stone is put into water, it exhales a musty smell, several bubbles of air arise, and it begins to grow gradually transparent. Some of these stones are colourless as soon as they are thoroughly transparent, others have a more or less deep yellow colour, others acquire a red ruby colour, and lastly, others acquire a beautiful mother of pearl colour, or of a bluish opal. Whatever be the colour of the liquor in which the hydrophanes is placed, it assumes only its usual degree of diaphaneity, and the colour that is peculiar to it. If while it is yet moist, and consequently transparent, it be obliquely looked at, a luminous point is perceived, which varies when its situation is altered. This luminous point is not, according to Mr. Bruckman, the immediate image of the sun, but a reflection of that image refracted in the very substance of the stone, a phenomenon which probably gave rise to the name of *Oculus Mundi*. The theory of
this

this phenomenon has been given by Professor Bergman, in his excellent treatise, *de Lapide Hydrophano*. Mr. Bruckman put a dry piece of this stone, weighing 35 grains, into water, and left it there seven hours, the space of time requisite to render it perfectly transparent; he then found it to have gained three grains in weight.

If the hydrophanes be put into hot water, it becomes transparent much sooner: the same happens if it be dipped in a very dilute acid, or which is still better in a very dilute alkali.

If it be dipped in oil of vitriol, it becomes transparent very quickly, and will continue so, because the acid lodged in the interior part of the stone attracts as much moisture from the air as is necessary to keep it transparent; but its opacity will return if it be dipped in a hot alkaline liquor.

S E C T. 98. (58.)

3. The Chalcedony, or white Agate,

Is a flint of a white colour, like milk diluted with water, more or less opake: it has veins, circles, and round spots. It is said to be softer than the onyx, but much harder than those agates, which are sometimes found of the same colour.

a. The white opake Chalcedony, or *Cacholong*, from the Bukarish Calmucks. This

was first made known by one Renat [r], a Swedish officer, who for several years had been in that country. The inhabitants find this flint on the banks of their rivers: and work idols and domestic vessels out of it [s].

Of white and semi-transparent strata from c. Ceylon.

Bluish grey, from Ceylon and Siberia [t].

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[r] He was taken prisoner in 1714, by the Calmucks, and remained with them till 1733, when he returned with an immense wealth, having taught the Calmucks to melt iron ore, to make gunpowder, and to cast cannon, and having been their leader in their wars against the Chinese. *J. R. Forster.*

[s] The Cacholong is a kind of white agate, very hard and compact: it is semi-transparent, and this seems the only circumstance by which it differs from the moon-stone of Sect. 99, which is of a milky white and blue bottom. It is vitrifiable, and may receive a very good polish. It is found in the river *Cache* in the Calmucks country, from whence it takes its name. These stones, and almost all of the agate kind, as well as some of the fine gems, are cut and polished with a convex surface, a form which the French call *Cabochon*. Dut.

This species is found also in the Feroe isle, where it lies on and between the strata of semidiaphanous chalcedony. It is never formed in drops: and seems to be a coarser variety of the true chalcedony. *Brun.*

[t] This too comes from the same place as the Cacholong, and is sometimes found in fine drops of considerable size. Count Thott in his excellent collection has such a one from Feroe. *Brun.*

To the above three, a fourth species of Chalcedony may be added, viz. The Hydrol Chalcedony [*Enhydre*, in French], so called on account of its being hollow, and almost filled with water, which circumstance renders these stones of some value among the curious: but some have such a porous texture that
in

S E C T. 99. (Additional.)

The Moon Stone is of a clear white colour, approaching to that of milk. When looked at in a certain position it reflects a strong light, like the mother of pearl: and in some spots a carnation colour. It is found in obtuse-angular pieces, which sometimes have a quadrangular figure. Its fracture is evidently foliated. It is very hard, and in other respects agrees with common felspat. Probably it is the *Androdymas* of Pliny: the common *Girafsole* of the Italians: and the *water Opal* of Ceylon. It is some times classed with the opal, and by others with the *Cat's-eye*. Werner.

This stone is of the chalcedony or pseudo-opal kind: it reflects a whitish light, with some various shades of few intermixed colours on a bluish bottom, like the shining face of the moon when it is high enough not to become reddish by the interference of the earthy vapours.

The Rainbow-stone, or *Iris*, seems to be no more than a Moon-stone, in which the yellow purple and blue reflected rays are the most conspicuous. See the last part of Note [p] to pag. 178, and Note [c] to pag. 162.

in process of time their water is entirely dried. It is said, however, that they may recover it again, if buried in a wet soil for a proper length of time. *Edit.*

This Chalcedony is semi-transparent, of a grey or brown bluish colour. Many of this kind are found in a mountain, containing various volcanic productions, near the city of Vicenza, belonging to the Venetian State. *The Edit.* from the Volcanic Mineralogy of Mr. Faujas.

S E C T. 100. (57.)

The Onyx. *Onyx Camebujæ. Memphites.*

This stone is the hardest of the flinty tribe, and consists of differently coloured veins, which run parallel to one another, sometimes in strait, sometimes in curved lines [u].

It is found of two sorts,

- a. Nail coloured onyx, having pale flesh-coloured, and white lines. From the river Tomm in Siberia.
- b. With black and white lines. The oriental onyx. The old Romans were accustomed to cut figures on the strait lined onyxes in relief, which they called *Camebujæ*: these are still counterfeited, and called *Camei*. Those, which consist of concentric circles were called *Memphites*, and we have now of this kind cut to be set in rings, under the name of *Occhi di Gatti*, which, however, ought not to be confounded with the pseudo-opal, (Sect. 95), or Cat's-eye.

[u] This stone loses its colour in the fire, and cracks or breaks if the heat be sudden or violent.

Its specific gravity is from 2500 to 2600. *Fabr.*

S E C T. 101. (59.)

4. The Carnelian, *Carniolus* [x].

Is of a brownish red colour, and often entirely brown. Its name was originally derived from its resemblance to flesh, or to water mixed with blood.

a. Red from the East, and Turkey.

b. Yellowish brown, looks like yellow amber, from the river Tomm, in Siberia. It is said not to be so hard as the chalcedony.

S E C T. 102. (60.)

5. The Sardonyx.

Is a mixture of the chalcedony and carnelian, sometimes stratum-wise, and sometimes confusedly blended, or mixed together.

a. Striped with white and red strata: this serves as well to cut in *cameo*, as the onyx.

b. White with red dendritical figures.

This very much resembles that agate which is called the Mocha-stone, but with this dif-

[x] It loses its colour in the fire.

Its specific gravity is from 2630 or 2700 *Fabr.*

ference,

ference, that the figures are of a red colour in this, instead of black, as in that agate.

I have unwillingly distinguished the onyx, carnelian, chalcedony, sardonyx, and agate, as separate species, since there is no real difference between them, except some inexplicable degrees of hardness; but I have been induced to continue these names for the reasons before given in Sect. 93 [y].

S E C T. 103. (61.)

6. The Agate, *Achates*.

This name is given to flints that are variegated with different colours, promiscuously blended together; and they are esteemed in proportion to their mixture of colours, their beauty and elegance [y*]. Hence also they have obtained variety of names, mostly Greek, as if the business of the lapidary in cutting of them, and the fondness of admiring their several beauties and figures, had been derived from that nation alone.

[y] The yellow and the orange coloured agates with a wavy or undulating surface like the *Chalcedony*, are now called also by the name of *Sardonyx*. Mongez.

[y*] Near the bridge, over the Mulda, not far from Freyberg, in Saxony, a red and white agate breaks in veins. This is called *Coral stone* in Italy. The agate of Rochlitz in Saxony is the most celebrated, and is found in globules which have a kind of crust about them. *Brun.*

As

As it ever was and must be very difficult to give intelligible descriptions of colours, we are for that reason quite at a loss to understand the meaning of the antients in this respect; but it indeed is of little consequence, as we seem to have the same right, under the same circumstances, of inventing new names for them; and that in whatever languages we please. Nevertheless I have described some few varieties of those which at this time are the most common, to serve as instances.

- a. Brown opaque agate, with black veins, and dendritical figures, the Egyptian pebble.
- b. Of a chalcedony colour, *Achates Calcedonians*.
- c. Semi-transparent, with lines of a blackish brown colour, and dendritical figures, the *Mocha stone*.

This is much esteemed, and makes a valuable part of some collections, where it has a place chiefly for the sake of its figures, resembling vegetables, animals, &c. which however are often improved by art.

- d. Semi-transparent with red dots, *Gemma divi Stephani*.

When the points are very minute, so as to give the stone a red appearance, it is by some called *Sardea*.

- e. Semi-transparent, with clouds of an orange colour.
- f. Deep red, or violet, and semi-transparent.
- g. Of many colours, and variegated.
- h. Black.

There

There are in Europe great quantities of most varieties of agates [z], particularly at Oberstein in the Palatinate, where they are cut and polished: but they are likewise found in every part of the world. In Sweden there is not yet, as far as I know, more than one species of agate found; namely, at Gasebeck, in the province of Skone, which is of a white and deep red colour.

[z] I have lately obtained a specimen of a hollow agate ball, with pale amethysts in the inside, between which is crystallized a calcareous substance into a fibrous form. These fibres are parallel, white, shining, and very minute, exactly resembling the finest asbestos, for which it also might be mistaken, if it was to be judged only by the eye. But by experiment it is found neither to be an asbestos nor gypsum, which sometimes shoots also in a fibrous form, but entirely a pure calcareous substance. The whole mass does not adhere together, but is divided into small triangles, which are placed upon one another, so as almost to form a large figure of the same kind. These fibres however, although very minute, may be observed by means of a proper magnifying glass, to be of an angular figure. The shape of balls and irregular nodules is the most general form in which agates and flints are commonly found. Nevertheless, besides what I have seen in several collections in London and elsewhere, I have likewise some specimens of native silver from Potosi in the Spanish West-Indies, which run in grey and blue transparent agate with white opaque veins. This seems to confirm the opinion, that agates may form veins in the rocks, as well as other sorts of stones. (See Sect. 106.)
Eng.

S E C T. 104. (62.)

7. Common Flint, *Silex communis*. *Pyromachus*,

Is really of the same substance as the agate, but as the colours are not so striking or agreeable, it is commonly considered as a different substance.

- a. Blackish grey, from the province of Skone.
- b. Yellow semi-transparent from France.
- c. Whitish grey.
- d. Yellowish brown.

When the flints are small, they are in England called *pebbles*; and the Swedish sailors, who take them as ballast, call them *singel* [a].

S E C T. 105. (63.)

8. Chert. *Petroflox*, *Lapis Corneus*, The *Hornstein* of the Germans.

Is of a coarser texture than the preceding, and also less hard, which makes it consequently not

[a] Common flint, is the *Kiesel* of the Germans. According to Mr. Weigleb, it contains 80 per cent. of *siliceous earth*, 18 of *Argil*, and 2 of calcareous earth. Its specific gravity is from 2650 to 2700. *Kirwan*.

so capable of a polish. It is semi-transparent at the edges, or when it is broke into very thin pieces.

- a. Chert of a flesh colour, from Carl-Schakt, at the silver-mine of Salberg, in the province of Westmanland.
- b. Whitish yellow, from Salberg.
- c. White, from Kristiersberg, at Nya Kopparberget in Westmanland.
- d. Greenish, from Prestgrufvan, at Hellefors in Westmanland [b.]

S E C T. 106. (Note to Sect. 63.)

Observations on Cherts.

There are not yet any certain characters known, by which the Cherts and jaspers may be distinguished from each other: by sight, however, they can easily be discerned, viz. the former

[b] Chert runs in veins through rocks, from whence its name is derived. Its specific gravity is from 2590 to 2700. In the fire, it whitens and decipitates like flint, but is generally so fusible as to melt *per se*.

It is not totally dissolved in the *dry way*, by the mineral alkali: but borax and microscopical salt dissolve it without effervescence.

Its appearance is duller and less transparent than common flint. The reddish Petro-flint used in the Count de Lauragat's porcelain manufacture, and called there *felt spat*, contained 72 per cent. of *flint*, 22 of *argill*, and 6 of calcareous earth. *Kirvan*.

(the

(the Cherts) appearing transparent, and of a fine sparkling texture, on being broken; whereas the Jasper is grained, dull, and opaque, having the appearance of a dry clay. The Chert is also found forming larger or smaller veins, or in nodules like kernels in the rocks; whereas the jasper, on the contrary, sometimes constitutes the chief substance of the highest and most extended chain of mountains. The Chert is likewise found plentifully in the neighbourhood of scaly lime-stone, as flints in the strata of chalk. What connection there may be between these bodies, perhaps time will discover.

But flints and agates being generally found in loose and single irregular nodules, and hardly in rocks, as the chert, it is a circumstance very insufficient to establish a difference between them; for there is the agate stone, near Constantinople, running vein-like across the rock with its country of the same hardness, and as fine and transparent as those other agates, which are found in round nodules at Deux-ponts. We must therefore content ourselves with this remark concerning flints, viz. That they seem to be the only kind of stone hitherto known, of which a very large quantity has been formed in the shape of loose or separate modules, each surrounded with its proper crust; and that the matter which constitutes this crust, has been separated from the rest of the substance, in like manner as *sandiver*, or *glass-gall*, separates from, and swims upon glass, during its vitrification; though sometimes the formation of this crust
may

may be prevented by the too sudden hardening of the matter itself: I shall therefore take the liberty to call this matter of the crust, which sometimes is an indurated *terre verte*, by the name of *agate-gall*.

Other species of stones, which are found in loose pieces or nodules, except ores and some sorts of stalactites, shew evidently by their cracks, angles, and irregular figures, that they have been torn from rocks, rolled about, and rubbed against one another in torrents, or by some other violent motions of water.

That flints had originally been in a soft state, as I have mentioned, is easy to be seen in the Egyptian pebbles, which have impressions of small stones, sand, and sometimes, perhaps grass, which, however, have not had any ingress into the very flint; but seem only to have forced the above *agate-gall* or crust out of the way.

S E C T. 107. (64.)

G. Jasper, *Jaspis*. (The Diaspro of the Italians.)

All the opaque flints are called by this name, whose texture resembles dry clay, and which have no other known quality, whereby they may be distinguished from other flints, except that they may be more easily melted in the fire; and this quality, perhaps, may proceed

proceed from the heterogeneous mixture, probably of iron [c].

1. Pure jasper. *Jaspis pura*.

Which, by no means yet known can be decomposed.

a. Green, with red specks or dots, the *Heliotrope*, or *blood-stone*, from Egypt.

b. Green, from Bohemia. (*Pavonia Aldrovandi*).

c. Red, *Diaspro rosso* of the Italians [d].

d. Yellow. (*Melites*) [e].

e. Red with yellow spots and veins, *Diaspro florido* of Sicily, Spain, and Constantinople.

f. Black, from Finland and Neskott, in the province of Jemtland. (*Paragone antico* of the Italians).

[c] These stones cannot be rendered electrical or phosphoric, either by friction, percussion, or heat.

They do not crackle in the fire, nor easily lose their colour.

They may be brought into fusion, either by alkalis, borax, or nitre.

They are insoluble in acids.

[d] Jasper. The *diaspro* of the Italians, contains about 75 per cent. of *sil x*, 20 of *argill*, and about 5 of calx of iron.

Its specific gravity is from 2680 to 2778. *Kirwan*.

[e] *Melites*, i. e. *malis coloris*. See Pliny, B. 37. c. 11. Bomare says, that this is the *Terebinthizusa* of the same; but this great Father of Natural History very clearly pronounces, that the *Terebinthizusa* is a variegated jasper. See his chap. 8. of the same Book 37. The Editor.

S E C T. 108. (65.)

2. Jasper, containing iron, *Jaspis martialis*.
Sinople [*e**].

A. Coarse grained.

a. Red and reddish brown, *Sinople*, from the Hungarian gold mines [*f*].

B. Steel grained, or fine grained.

a. Reddish brown, from Altenberg, in Saxony; looks like the red ochre or chalk used for drawing, and has partition veins, which are unctuous to the touch, like Colnish (or Cologne) clay, serpentine, &c.

C. Of a close and shining texture like a flag.

a. Liver-coloured, and

b. Deep red. Both these are found at Langbanshyttan in the province of Wermeland, and at Sponwick in Norway.

c. Yellow, from Bohemia.

This last mentioned, when calcined, is attracted by the load-stone, and being assayed, yields from 12 to 15 per cent. of iron.

[*e**] *Sinople* is a dark red jasper: this contains 18 or 20 per cent of iron. *Kirwan*.

[*f*] Near Chemnitz, where it forms very considerable veins. It has frequently specks of marcasite, cubic lead ores and blend: and the gold it contains is worth working; there is likewise a striped *Sinople*, of various colours. *Brun*.

S E C T. 109. (Note to Sect. 65.)

Observations on Jaspers.

Jasper, when fresh broken, so nearly resembles a bole of the same colour, that it can only be distinguished by its hardness. In the parish of Orsa, in the province of Dalarne, there is a red bole found resembling glands or kernels, in that kind of sandstone, from which grindstones are cut; and some miles distant in the rocks of Serna, a red jasper of the same colour and texture, as the above bole, is found in a much harder kind of sandstone. In other places jasper is found within such unctuous clefts as Colnish clay, red chalk and other clays usually have: and there are likewise some jaspers which imbibe water. May it not then be supposed, with some probability, that jasper is an indurated bole, a reddle, or *terre verte*? That jasper as well as these, has for its basis clay and iron; though by reason of its being hardened, it becomes as difficult to extract these principles from it as to reduce a small quantity of scorified iron to its metallic form, when melted with a large quantity of slag or glass? That the same bole or clay, together with another substance, perhaps lime, enters into the mass, which, after being dissolved by a menstruum not yet determined, forms flint? And that so much of

the bole as was superfluous, being separated from the mass, is found adhering to the surface, or in the fissures, &c. [g].

Thus

[g] Jasper is infusible *per se*, with the blow-pipe: with the mineral alkali it is only partially soluble, separating itself with effervescence, into small particles: but it melts with *borax* or *microcosmic salt*, without any effervescence.

According to Bergman, in his *Sciagraphia*, it is composed of *Siliceous earth* united to an argill very full of iron. The mineral acids have no action upon jasper in a short time, but at the end of some months it is found corroded, if immersed in them. A small piece of green jasper having been treated with the vitriolic acid, gave some crystals of alum, and some martial vitriol, which demonstrates that argill and iron enter into its composition.

Mr. Daubenton mentions 15 varieties of jasper. 1. The *green*, from Bohemia, Silesia, Siberia, and the shores of the Caspian sea. This seems to be the *Pavonium* of Aldrovandus. 2. The *red*, or the *diasparo rosso* of the Italians, which is not so common, nor in such great masses as the *green*. 3. The *yellow*, from Freyberg and Rochtliz: it is sometimes of a citron colour, and looks as if composed of silky filaments. This is called the *Silk jasper*. 4. *Brown*, from Dalecarlia, in Finland and Sweden. 5. The *violet*, from Siberia. 6. The *black*, from Sweden, Saxony, and Finland: this is the *Paragone antico* of the Italians. 7. The *bluish grey*, which is very rare. 8. The *milky-white*, of which Pliny speaks: it is found in Dalecarlia. 9. The *variegated* with *green*, *red*, and *yellow* clouds. 10. The *Blood-stone*, which is green with red specks, from Egypt, and was supposed to stop the blood. 11. The *veined*, with various colours. When these veins have the resemblance of letters, it is then called *jaspé grammatique*, by the French. Some of this kind are found near Rochelle, in France, and called *polygrammatiques* by the curious in these trifling accidental qualities. 12. That which has various coloured zones. 13. That called *forito* by the Italians, which has its various colours

Thus one might imagine that jasper is still produced, and that the soft kinds might become harder by length of time ; but its particles cannot be supposed to approach nearer and nearer to one another during the hardening ; nor can it be imagined, that jasper should, by that means become of a finer texture. On the other hand, we know extremely well, and have the experience of it every where, that porphyry in the rock decays into a white crust, whenever it is exposed to the air, -although internally it remains very hard and black ; for instance, at Klitten in Elfdalen in Sweden. From whence it may be supposed that water which washes off the mouldered particles, must, by degrees, collect them somewhere ; and at length present us with them in the form of an earth, which, perhaps, we do not know again in that state. It may likewise be asked, whether this earth will be ductile like clay, or rough to the touch like powder of bricks ? Perhaps Tripoli is produced in this manner.

colours promiscuously, without any order. 14. When the jasper has a great number of colours together, it is then (very improperly) called *universal*, 15. Finally, when the jasper is found to contain some portions of agate, it is then called *agatized jasper*. The *Editor*, chiefly from *Mongez*, in his *Notes to Bergman's Sciagraphia*.

S E C T. 110. (66.)

Rhombic Quartz, *Spatum Scintillans*. *Feldspatum*. (The Chinese *Petuntse*) [b].

This has its name from its figure[i], but seems to be of the same substance as the jasper. I have not however ranked them together, for want of true marks to distinguish the different sorts of the flinty tribe from one another.

This kind is found,

1. Sparry.

a. White.

b. Reddish brown. This occurs in the Swedish, and also the foreign granites.

c. Pale yellow.

d. Greenish.

This last mentioned resembles very much the schörl or cockle-spar, but is neither so easy to melt in the fire, nor of so regular a figure,

2. Crystallised.

[b] This spar gives fire with steel, and melts in a violent heat. —By means of acids, a large quantity of argillaceous and siliceous earths may be separated from it; also a smaller proportion of magnesia, and a still smaller of calcareous earth and iron, according to Mr. Bayen's analysis.

[i] The German word *feld* signifies a *field*, and likewise a *compartment*, or *regular surface*. Thus *feld-spat* means a *spar* composed of *little compartments of rhombic or other figures*. J. R. Forster.

A. In

A. In separate or distinct rhomboidal crystals, from the iron mine called Mossgrufvan, at Norbery in Westmanland [*k*].

S E C T. III. (Additional.)

Labrador Stone. *Spatum rutilum versicolor*. It is but a few years ago (9 or 12) that this beautiful stone began to be known in Europe: it is brought from the coast of Labrador, where the Moravians, who have a colony among the Eskimaux, first discovered it. Its colour is commonly of a light or of a deep grey, and mostly of a blackish grey: but when held in certain positions to the light, discovers different varieties of

[*k*] This species is very seldom found alone in form of veins, and still more rarely as constituting the substance of whole mountains; but is generally mixed either with quartz and mica, when it is called Granite, in Swedish Gräberg; or with jasper, having some occasional concurring particles of quartz, cockle, and hornblende, in which case the compound is called porphyry. If the rhombic quartz and jasper were of the same species, that sort of porphyry, which is made up of these two bodies only, ought to be ranked among the jaspers, instead of being placed with the Saxa.

It is however observable on old monuments, which are exposed to the open air, that though porphyry had decayed, and consequently lost its polish, yet granite of the same age, composed for the most part of rhombic quartz, has kept its lustre. This, however does not contradict the possibility of rhombic quartz being of the same substance as the jasper; the calcareous spar, for instance, is found to bear the weather, and even fire, better than the limestone. *The Author.*

beautiful shining colours, as lazuly-blue, grass-green, apple-green, pea-green; and seldom a citron-yellow; some have an intermediate colour betwixt red-copper and tombac-grey; besides other colours between grey and violet. These colours are seen for the most part in spots; but sometimes in stripes, on the same piece.

These stones are found of an angular form, in pretty large pieces. Their specific gravity is 2,755. Their fracture appears foliated: and the broken parts are rhomboidal: they are semi-transparent: and in other respects agree with the felt spar.

The best description of this stone has been given by Messrs. Lesh and Brukman. I have seen at Geyer a piece of feldspar, which displayed a great variety of colours: but very pale. *Werner*,

S E C T. 112. (Additional.)

White felspar. *Terra Silicea Magnesia & ferro intimè mixta.*

This stone has been described by Mr. Bayen: and it is found at *St. Marie aux mines* in Lorraine.

It is of a white opaque colour, spotted with ochre on the out-side. Its texture is solid and opaque, consisting of shining particles, which give it a sparry appearance. It is very hard, and strikes fire with steel; it is attacked by acids,
and

and it appears by the analysis that siliceous earth composes half its weight, magnesia and iron compose the other half. That from Alençon contains some calcareous earth, and more iron than any other of the kind.

S E C T. 113. (Additional.)

Observations on Felt Spar, (from Kirwan.)

This stone, which is generally opaque, is found of all colours, white, red, yellow, brown, green, violet, or viridescent; sometimes crystallized in rhombic, cubic, or parallelepipedal forms, and often amorphous. Its texture is close but lamellar and it breaks like spar. Its specific gravity is from 2400 to 2600. Mr. Gerhard says he found it even 3500, but it was then probably loaded with metallic particles. It is harder than fluors, but not so hard as quartz.

It melts *per se* more quickly and perfectly than fluors, into a whitish glass, and does not, like them, attack the crucibles. Borax and microcosmic salt entirely dissolve it without effervescence, but it does not easily enter into fixed alkalis. When crystallized it decrepitates in a moderate heat, otherwise not.

It never constitutes veins, or strata, but is either found in loose masses, at most two inches long, or mixed with sand or clay, or imbedded in other stones, as granites, &c.

One

One hundred parts of the white contain about 67 of siliceous earth, 14 of argillaceous, 11 of ponderous, and 8 of magnesia.

Felt spar is undoubtedly the stone which the Saxons use as Petuntse in their porcelain manufactories.

S E C T. 114. (69.)

The Garnet kind: *Terræ Granatæ.*

The matter composing the substance of *Garnets*, and *Schörls* or cockles, except the small portion, which is metallic, does, in its indurated state, resemble the siliceous tribe, so far as relates to external appearance and hardness: and therefore I would very willingly have followed the opinion commonly received, of considering these two substances as arising from one another; if I had not been persuaded to the contrary by the following qualities of the Garnet [1].

[1] The substances of this order are analogous to gems: since all these are composed of the *siliceous*, *calcareous*, and *argillaceous* earths, with a greater or less proportion of iron. The opaque and black garnets contain about 20 hundredths of iron: but the diaphanous ones only 2 hundredths of their weight, according to Bergman. The garnets, properly so called, contain a greater quantity of siliceous earth than the shirls, and both are now justly ranked with the *siliceous* earths.
Edit.

1. It is more fusible, in proportion as it contains less metallic matter : and is more transparent or glassy in its texture : which is quite contrary to the siliceous kind.
2. This is the reason, perhaps, why the garnet, mixed with the salt of kelp, may, on a piece of charcoal, be converted to a glass by the blow-pipe, which cannot be done with the flints : and,
3. Why the most transparent garnet may, without any addition, be brought to a black opaque slag by the same means.
4. It is never, so far as is hitherto known, found pure, or without some mixture of metal, and especially *iron*; which may be extracted by the common methods [*b*].
5. The garnet matter, during the cristallization, has either been formed in small detached quantities ; or else has had the power of shooting into cristals, though closely confined in different substances : since garnets are generally found dispersed in other solid stones, and oftentimes in the harder ones, such as quartz and chert [*i*].

SECT.

[*b*] The garnet is easily melted with borax, or with the vegetable alkali. *F.*

Its specific gravity is greater in general than that of precious stones, viz. from 3600, and even from 4400 to 1000. *F.*

Most of the garnets strike fire with steel. *Brun.*

[*i*] It is certain that the metallic calces being mixed with other earthy substances, make great alteration in respect to their

S E C T. 115. (69.)

1. Garnet, *Granatus*.

Which is a heavy and hard kind of stone, cristallizing in form of polygonal balls, and is mostly of a red, or reddish brown colour.

A. Granet mixed with iron, *Granatus martialis*.

1. Coarse grained garnet-stones, without any particular figure. *Granatus particulis granularis, figura indeterminata*: in Swedish called *Granat-berg*: in German *Granatstein*.

a. Redish brown garnet, from the mine called Granate-skierpningen, at Nya Kopparberg, in Westmanland.

their fusibility; and we know from experience, that the presence of iron, particularly in the argillaceous, and in the micaceous kinds, renders them fusible; however, though there may be good reasons for considering the garnet as a quartz impregnated with iron; yet as quartz is not so easily subdued by any addition of iron, of which the Swedish *Torsåen*, a martial ore, commonly mixed with quartz, is an instance; and as even the species of quartz naturally mixed with that metal, are far less easily fusible than the garnet; it will, perhaps be better to call the garnet a stone of a different order, until by sufficient experiments we may have reason to reduce the number of the earths. Though if we should ever arrive at an exact method of classing them in this respect, perhaps the economical use of these bodies will rather require such a distribution of them as shall more regard their present existence, than that which they have been originally derived from.

The garnet earth, so far as I know, is not yet found, but in an indurated state; and, as such, it is divided into the garnet, and into shirl or cockle, and that in regard to the figure of their cristals, more than any thing else, though their colour has also had some share in this division. I have here followed custom, which, perhaps, may have some reason, however ill founded it be. *The Author*.

b. Whitish

- b. Whitish yellow, from Torrakeberget, in the parish of Gornborn, in Wermeland.
- c. Pale yellow, from Sikfioberget, and Wester Silfverberget, in Kopparbergslän in Sweden [k].

S E C T. 116. (69.)

2. Crystallized. *Granatus Crystallizatus.*

- a. Transparent, *Granatus Gemma*. See Sect. 84, where a new article has been added on this gem.
- b. Reddish yellow transparent, the jacinth, or hyacinth. *Hyacinthus gemma* [l]: from Greenland, and Bergens Stift, in Norway. See Sect. 82.
- c. Red semi-transparent, and cracked, from Engso, at the Lake Malaren, in Westmanland.
- d. Reddish brown, from Kalmora and Stripas, at Norberg, in Westmanland.
- e. Green, from Eibenstock in Saxony; and Gellebeck in Norway.

[k] Garnets, though small, are often found in micaceous stones in England; but extremely good garnets are found in great plenty also in like stones in Scotland. D. C.

Near Zoblitz, in Saxony, a number of garnets stick in a serpentine rock, which bassets to the day. Brun.

[l] I am not certain whether the oriental jacinth, and that from Siberia are of the same kind: but this garnet from Greenland is sold by the jewellers as a hyacinth. Author.

f. Yel-

f. Yellowish green, from Gellebeck.

g. Black, from Swappawari, in Lapland [m].

S E C T. 117. (70.)

B. Garnet mixed with iron and tin, *Granatus crocis Martis et Jovis mixtus*.

1. Coarse grained, without any particular figure, *Granatus particulis granulatis figura indeterminata*.

a. Blackish brown, from Moren, at Westanfors, in Westmanland.

2. Crystallised.

a. Blackish brown, from Moren.

b. Light green or white, from Gokum, at Dannemora, in the province of Up-land.

The Bergs-radets, or mine-masters, Mr. Brandt and Mr. Rinman have published some experiments on this kind of garnet, in the Memoirs of the Royal Academy of Sciences at Stockholm.

[m] The cristallization of garnets are so far different from one another, that some have a greater and some a less number of facets, or sides: but this has no relation or dependence on their contained metals, their colour, or their transparency. Wherefore, in order to avoid a prolixity, which is unnecessary, I have omitted such varieties; and only observed that they are round or spherical, with facets. Besides, there is not yet discovered any figure amongst them, which is absolutely particular and remarkable: for the *granatus dodecaedros ex rhombis* of Linneus, is dispersed every where in the rocks at Konigsberg in Norway. *The Author.*

S E C T. 118. (71.)

C. Garnet mixed with iron and lead, *Granatus calcibus Martis et Saturni mixtus*.

1. Crystallised.

- a. A reddish brown, from Arfet, in the parish of Foderyd, in the province of Smoland.

This was discovered, and accurately examined by the Bergradet Mr. Von Swab.

S E C T. 92. (119. (72.)

Cockle or Shirl, (*Schoerlus* of Bergman). *Lapis Corneus Crystallifatus Wallerii*.

Stannum Crystallis Columnaribus nigris. Linnæi (n).

It is a heavy and hard kind of stone, which shoots into crystals of a prismatic figure, and whose chief colours are black or green.

[n] According to Sir Tobern Bergman, shirls or schoerls ought not to be confounded with basaltcs. This last name does not fit the substances, the author describes in this and the three following sections. *Edit.*

2. Its specific gravity is the same as the garnets, viz. between 3000 and 3400, though always proportional to their different solidity [o].

A. Cockle or shirl [p], mixed with iron, (*Shoerlus martialis*.)

1. Coarse, without any determined figure, *particulis palpabilibus figura indeterminata*.

a. Green, found in most of the Swedish iron mines.

[o] 3. It cracks in the fire : and,

4. Is very difficult to be fused : neither the microcosmic salt nor the mineral alkali can effect its fusion.

5. It is not totally soluble in *aqua fortis*.

6. But whatever is dissolved, may be reduced into a jelly, by the addition of an alkali.

7. It is a compound of a siliceous earth, argill, calcareous earth and iron : this last is found in a greater quantity when the cockle is opaque than when it is transparent. *F.*

8. Some shirls contain 55 parts of siliceous earth : 39 of argillaceous, and 6 of pure calcareous earth ; but some contain 12 or 20 parts of magnesian earth, &c. *Berg. See the Table after Sect. 72. N° 12 and 13.*

[p] The name Cockle for these substances is an old Cornish mineral name ; but it is also given sometimes to other very different matters.

The name of shirl is now adopted in English, from the German mineral term. We have not in England any great quantity of species of cockles ; the chief are found in the tin mines in Cornwall, and I have seen some fine cristallized kinds from Scotland. D. C.

The English mineral name of *Ca'l*, has been used by some authors as synonymous with cockles, and these are even confounded together at the mines ; but the *Call*, definitely speaking, is the substance called *Wolfram*, by the Germans, &c. D. C.

S E C T. 120. (73.)

2. Sparry, *Schoerlus Spatosus* [q].
- a. Deep green, (the mother of emeralds) from Egypt [r].
 - b. Pale green, from Westersilfverberget and Hagge, at Norberke, Linbasmören, at Grangierde, in the province of Westmanland, &c.
 - c. White, from Silf-udden, at Westersilfverberget, Pargas in Finland, the lime-rocks at Lillkyrkie, in the province of Nerike, &c. [s].

This occurs very frequently in the scaly limestones, and the colour of the sparry schoerl changes from deep green to white, in proportion as it contains more or less of iron.

S E C T. 121. (74.)

3. Fibrous, *Schoerlus particulis fibrosis*; striated cockle, or shirl: it resembles fibres or threads of glass.

[q] Its specific character is, that it always breaks in a cubic or in a rhomboidal form. *Fabr.*

[r] The Plasma, or mother of emeralds of authors, is a fine pellucid true shirl, or cockle, as it has been said in Sect. 81. pag. 147. *Editor.*

[s] d. Brown, from Westmorland.

e. Black, from Kailmora in Norberg. *Fabr.*

- A.* Of parallel fibres, *Schoerlus fibris parallelis* [t].
- a.* Black, from Gustavsberget, in the province of Jemtland, the island of Uto, in the lake Malaren, &c.
 - b.* Green, in most of the Swedish iron mines.
 - c.* White, from Westerfilfverberget, in the province of Westmanland, Lillkyrkie in Nerike, and Pargas in Finland.
- B.* Of concentrated fibres, *Schoerlus fibris concentratis*; starred cockle or shirl, from its fibres being laid stellarwise.
- a.* Blackish green, from Salberg, in Westmanland, where, being found together with a steel grained lead ore, the whole is called *gran-ris-malm*, or pine-ore, from its resemblance to the branches of that tree. This kind of metal is also found at Uto, in Malaren.
 - b.* Light green from Kerrbo, at Skinskatteberg in Westmanland.

[t] To this species of cockle, or shirl, belong most of those substances called *imperfect asbesti*; and as the cockle perfectly resembles a slag from an iron furnace, both in regard to its metallic contents, and its glassy texture, it is no wonder that it is not soft enough to be taken for an asbestus. It has however, only for the sake of its structure, been ranked among the asbesti; and it is surprizing, that the fibrous gypsum, from Andrarum, in the province of Skone, has escaped being on the same account confounded with them. The striated cockle, or shirl, compared to the asbesti, is of a shining and angular surface, (though this sometimes requires the aid of the magnifying-glass to be discovered) always somewhat transparent, and is pretty easily brought to a glass with the blow-pipe, without being consumed, as the pure asbesti seem to be. (See Asbesti, Sect. 67). *The Author.*

c. White

- c. White, at Lillkyrkie in Nerike, Wester-silfverberget in Westmanland, and Pargas in Finland.

S E C T. 122. (75.)

4. Crystallized cockle, or shirl, *schoerlus crystallifatus*.

a. Black, from France, Yxio at Nya Kopparberg, in the province of Westmanland, Umea in Lapland, Osterbotten in Sweden.

b. Deep green from Salberg in Westmanland.

c. Light green, from Enighets-grufvan, at Norberg in Westmanland.

d. Reddish brown, from Sorwik, at Grengie in Westmanland, and Glanshammar, in the province of Nerike [u].

The Tauffstein, from Basil [x], is of this colour, and consists of two hexagonal cristals of

[u] The bar-schoerl, or *Stangen schoerl* of the Germans was lately found in the Carpathian mountains, by M. Fichtel, embodied in lime-stone and crystallised in prisms. It slightly effervesces with acids: and contains 61,6 of *silica*: 21,6 of *calx*: 6,6 of *argil*: 5 of *magnesia*: 1,6 of *iron*: and 3. of *water*. Kirwan.

[x] It is found, though very rarely, near Basil, a known town of Switzerland.

N. B. Mountain cristal is sometimes found in the form of a Cross: so that this figure is not peculiar to the shirl kind:

of cockle grown together in form of a cross: this the Roman Catholics wear as an amulet, and is called in Latin, *Lapis crucifier*, or the cross stone [y].

S E C T. 123. (76.)

Observations on the Granet and Schorl or Cockle kind.

When this kind contains so much of iron as renders it profitable to be worked, it is considered as a good iron ore, and no notice is taken

Werner. Some of this form are found in Germany, mentioned by Bergman, (*de form Crystall.* p. 7.) which have the appearance of calcareous, though in reality they belong to the siliceous kind. *Ed.*

The reddish brown prismatic shirl from Mount Vesuvius, contains 48 per cent. of *silicæ*: 40 of *argilla*: 5 of *calx*: 1 of *magnesia*: and 5 of *iron*. But other sorts of shirl have afforded 50 per cent. of *siliceous earth*: 30 of *argillaceous*: 1 or 2 of *magnesian earth*: and 18 or 20 of *iron*. Bergman,

The white sort probably contain less iron.

But all shirls become reddish by calcination. *Kirwan.*

[y] It is not impossible, that there may be some kinds of cockles, or shirls, which, besides iron, also contain tin or lead, as the garnets: but I am not quite convinced of it; though I have been told, that lead has been melted out of a cockle, from Rodbeck's-Eng at Umea, in Lapland; and it seems likewise very probable that the cockles which are found in the English tin mines, may contain some tin. There are some cristals of cockle found, which are fusible in a greater degree than any sort of stone whatsoever: these are always of a glassy texture, and semi-transparent.

The figure of the cockle cristal is uncertain, but always prismatical: the cockle from Yxjö, at Nya Kopparberg, is quadrangular; the French kind has nine sides, or planes; and the Tauffstein is hexagonal. *The Author.*

of

of its natural character, in the same manner as is done with clays and jaspers that contain iron; for the richness of metal in these rises in a gradual progression, till they acquire the appearance of Iron itself. Thus a kind of garnet is melted in a furnace, not far from Eibenstock, in Saxony: and the same species is found, and might also be employed, at Moren, in Westmanland. Jaspers are for this purpose melted in Hungary, and clays in England. But as the greatest part of the garnet kind contains so little iron as to yield only between six and twelve per cent. which is too poor to be worked any where in the world as a profitable iron ore, the rest and the greatest part being a mere earth, it must in a natural history be considered and ranked among the earths [z].

The tin grains should have obtained a place in this order, 1. If I had known any of them to contain tin in so small a portion as five per cent. as this quantity of tin is the most that ever can be obtained from the garnets; 2. If it was proved that a calx of iron always was mixed with it, as in the garnet; and, 3. If I did not believe that the tin calx might by itself take a

[z] When any of the garnet kind is to be tried for its containing metal, the iron ought to be melted out of it by the common process; and if the garnet, at the same time, contains both tin and lead, these two metals are likewise included in the iron: however, they may be extracted out of the iron, by exposing it to a heat augmented by degrees, because then the tin and lead sweat out in form of drops, almost pure, though always somewhat mixed with iron. *The Author.*

spherical polygonal figure, at its induration, as well as the garnet. The white tin grains, out of which no tin, but only iron is to be got, might with more reason be placed here, if it was not so excessively refractory in the fire, and if it did not, at last, melted either by itself, or with borax, give a clear and colourless glass, contrary to what the garnet does, which difference arises from the different fusibility of these two substances.

The garnet and cockle are not yet known to me in form of an earth or clay, taken in the common idea we have of those bodies. It is true, that there is a bole found at Swappawari, in Lapland, which has the same figure as the garnet; and the hornblende of the author, which is somewhat harder than this bole, has often the appearance of a cockle. We cannot, however, do more than problematically suppose them to be the nearest related to the garnet kind, as we have not yet discovered a method how to separate earths from the contained metals, without destroying their natural form, and especially from iron, when it is so strongly united with them, as if it had a part in their formation itself.

S E C T. 124. (Additional from Kirwan.)

Rowly Rag.

This stone is of a dusky or dark grey colour, with numerous minute shining crystals.

Its texture is granular: by exposure to the air it acquires an ochry crust.

Its specific gravity is 2748.

Heated in an open fire it becomes magnetic.

In strong heat it melts *per se*, but with more difficulty than basaltes.

According to Dr. Withering's analysis, 100 parts of it contain 47,5 of *siliceous* earth, 32,5 of *argil*, and 20 of *iron*.

S E C T. 125. (Additional from Kirwan.)

Siliceous muriatic spar.

This stone is of a hard, solid, and sparry texture: of a grey, ochry, dull colour, but internally bright.

It gives fire with steel. Yet

It effervesces with acids.

In a strong heat it grows brown : but at last it melts *per se*.

100 parts of this stone contain 50 of *silica* : the remainder is mild *magnesia* and *iron* ; but in what proportion is not mentioned. See *Journal de Physique*, Supplement, vol. 13, p. 216.

S E C T. 126. (Additional from Kirwan.)

Turky Stone. (Cos Turcica.)

This stone is of a dull white colour, and often of an uneven colour, some parts appearing more compact than others, so that it is in some measure shattery. It is used as a whetstone : and those of the finest grain are the best hones for the most delicate cutting tools, and even for *razors, lancets, &c.*

Its specific gravity is 2598.

It gives fire with steel, yet

Effervesces with acids.

Mr. Kirwan found that 100 parts of it contains 25 of mild *calcareous* earth, and no *iron*.

There probably are two sorts of stones known by this name, as Mr. Wallerius affirms that, which he describes, neither to give fire with steel, nor effervesce with acids [*a*].

[*a*] Workmen affirm that this stone hardens with oil ; but this is a circumstance that I never could observe. *Editor.*

S E C T. 127. (Additional from Kirwan.)

Ragg Stone.

The colour of this stone is grey. Its texture is obscurely laminar, or rather fibrous, but the laminæ or fibres consist of a congeries of grains of a quartzzy appearance, coarse and rough.

Its specific gravity is 2729.

It effervesces with acids, and

Gives fire with steel.

Mr. Kirwan found it to contain a portion of mild *calcareous* earth, and a small proportion of iron.

It is used as a whet-stone for coarse cutting tools.

The siliceous grit, cos arenarius, and other compounds of the siliceous earth, &c. will be found in the Appendix, at the end of this Mineralogy.

S E C T. 128. (67.)

Observations on the Siliceous Order.

The œconomical uses of this Order are not so manifold as those of the calcareous and argillaceous classes; however, moral reflections laid aside, it will be necessary briefly to mention, how far this order is considered and employed in common life [*b*].

The

[*b*] This, like the other primitive earths, is seldom found pure, as have been mentioned, (Note *f* to Sect. 88). And of course

The Europeans have no farther trouble with the precious stones than either to cut them from their natural or rough figure, or to alter them, when they have been badly cut in the East Indies: in which latter circumstances they are called *Labora*: and it may be observed, that
for

course it will be very proper to give here the method of purifying this earth, as it is only in this state of purity that we can reason about its peculiar properties. The following is the process given by Professor Bergman for this purpose. Reduce clear *quartz crystals* into powder: melt it with four times the weight of *fixed alkali*: dissolve the whole in water: precipitate it by a large quantity of strong acid: wash carefully, and dry the precipitate.

The acid must be used in a superfluous quantity, that any other earths there contained may be dissolved.

The specific gravity of this earth so purified, is 1975. The particles, when first precipitated, occupy, in water, at least twelve times the space they do when dried. So that, when sufficiently fine, they remain suspended therein: Nay, when vehemently heated in a close vessel, as in the *Papin's digester*, they may be dissolved; as it will appear by the phenomenon observed at Geyser in Iceland, of which mention will be made hereafter at Note [f], pag. 223.

No acid, except that of the *sparry fluor*, mentioned Sect 22, has any action upon this earth. Fixed alkalis unite with it in the *humid way*: but in the *dry way*, they seize it with great vehemence, and convert twice their weight of it into a permanent transparent glass. Such is its affinity to alkalies, that it imparts to clay, which is always loaded with this kind of earth, the power of separating the alkaline bases from the acid of *nitre* and *common salt*.

When siliceous earth is quite pure, it is refractory in the fire: but although it is not found altogether simple, yet, in mineralogy, it must be considered as primitive, until decisive experiments shew us from which of the preceding or following earths it is derived. *The Editor, from Bergman's Sciagraphia.*

It

for cutting the ruby, spinell, ballas, and chrysolite, the *oil of olive* is required instead of any other liquid, to be mixed with the diamond powder, in the same manner as for cutting the diamond itself [c].

If

It seems that a further knowledge on this subject may be obtained, if a set of proper experiments was instituted on the earth that is precipitated from the *liquor silicum*. This has not yet been pursued by any one that we know. But the results which are reported in the French abridgment of G. Newman's chemical works, by the late Mr. Roux (printed in 4to, 1781, pag. 46,) seem to indicate that *siliceous earth* is a compound: as it is asserted there, that half an ounce of vitriolic acid has dissolved 20 grs. of this earth, precipitated from the *liquor silicum*. The same quantity of nitrous acid only dissolved 16 gr.: the same of muriatic acid dissolved 15 gr.: as much of *aqua regia* dissolved the like quantity: and the same of distilled vinegar dissolved only two gr. And that each of these solutions were differently coloured, viz. that made by the vitriolic acid, was *reddish*; that by the nitrous acid was *yellow*; that by the marine acid was only of a *yellowish* colour: that by the *aqua regia* was of a full *yellow* like gold: and that by the distilled vinegar did not change to any colour. But it is not said what was the proportion of each solution, an object which could be easily obtained by attempting the precipitation of each, with substances of a stronger affinity to each acid, and by a proper evaporation and crystallization of their respective residues. *The Editor, from Mongez.*

[c] This article, in the first English edition runs so, *And it may be observed, that for cutting the ruby, spinell, ballas and chrysolite, the oil of vitriol is required, instead of any other liquid, to be mixed with the diamond powder.* This certainly seems to be a mistake of the printer or of the editor, as it is well known that no oil of vitriol is, nor can be, employed by the lapidaries for cutting these hard stones with metallic wheels, without corroding their tools in a short time, as well as producing many other obvious and insufferable inconveniencies.

I have

If the petty princes in those parts of the Indies, where precious stones are found, have no other power nor riches proportionable to the value of these gems, the reason of it is as obvious as of the general weakness of those countries where gold and silver abound, viz. because the inhabitants, placing a false confidence in the high value of their possessions, neglect useful manufactures and trade, which by degrees produces a general idleness and ignorance through the whole country.

On the other hand, perhaps, some countries might safely improve their revenues by such traffic. In Saxony, for example, there might probably be other gems found, besides aqua-marines and topazes; or even a greater trade carried on with these than at present, without danger of bad consequences; especially under the direction of a careful and prudent government.

The half-precious stones, so called, or gems of less value, as the common opal, the onyx, the chalcedony, the cornelian, and the coloured and colourless rock crystals, have been employed for ornaments, and æcomical utensils, in which the price of the workmanship greatly exceeds the intrinsic value of the stones. The ancients used to engrave concave and convex figures on them, which now-a-days are very highly va-

I have seen how lapidaries cut diamonds: I have procured all the information I could: and I have read the article *Lapidary*, both in the *English Cyclopædia*, and in Jaubert's *Dictionary of Arts*: But I do not find the least intimation concerning the use of oil of vitriol in this operation. *Edit.*

lued,

lued, but often with less reason than modern performances of the same kind. These stones are worked by means of emery on plates and tools of lead, copper, and tin; or with other instruments: but the common work on agates is performed at Oberstein, with grind-stones at a very cheap rate. When once such a manufactory is established in a country, it is necessary to keep it up with much industry and prudence, if we would wish it to surmount the caprice of fashions; since how much soever the natural beauty of these stones seems to plead for their pre-eminence, they will at some periods unavoidably sink in the esteem of mankind: but they will likewise often recover, and be restored to their former value.

The grindstones at Oberstein are of a red colour, and of such particular texture, that they neither become smooth, nor are they of too loose a composition.

Most part of the flinty tribe is employed for making glass, as the quartz, the flints, the pebbles, and the quartzose sands[d]. The quartz, however, is the best: and if used in due pro-

[d] None of the siliceous stones are found crystallized in cavities, and if there are crystallizations, they consist of minute quartz crystals. Common flints some times contain impressions of marine productions, the hollows being often filled with them. This species is generated in the clefts of chalk-hills, as quartz is in the *Saxum* or rock-stone. The chalcedony-like agate, on the Italian Alps, have penetrated some shells, and filled their windings or thalami. Agates in wood, cornelians in shells, and flints in corals, have been mentioned by the author, Sect. 282 of the Appendix. *Brun.*

portion with respect to the alkali, there is no danger of the glass being easily attacked by the acids; as has sometimes happened with glass made of other substances; of which we had an instance of bottles filled with Rhenish and Moselle wines, during the time of a voyage to China[f].

In

[f] The siliceous earth, is it a simple substance or a compound one? And, in general, are all earths true elementary substances, or are they formed from other elements?— We have already mentioned the erroneous opinion of the siliceous earth being produced, in certain circumstances, by the intimate combination of the sparry-acid with water (Note b to Sect. 26): and as to the metallic earths, it is certain that the calx of arsenic is a compound of an acid with phlogiston: but we know not as yet with certainty, whether other earths are in the same case. Thus a few facts, however, may induce us to suspect, as the great Bergman does, that perhaps all other metallic earths are but so many compounds from acids and phlogiston: and that the other earths are but the result of different combinations in which the acids and phlogiston are the chief ingredients.

Our knowledge does not yet extend to the determining how hard crystals are formed, though it is certain that they must have been at some period of their formation in a soft state, since some are found to include water in their cavities, as has already been observed. Professor Bergman obtained thirteen regular formed crystals, by suffering the powder of quartz to remain in a vessel with the fluor acid for two years. These crystals were about the size of small peas, and were not so hard as quartz. (*See Opusc. de terra silicea*, p. 33.) Mr. Achard, in a letter dated the 6th of April, 1778, sent me two crystals, one of the sparry kind, and the other as hard and transparent as rock crystal. The first he procured by means of calcareous earth, and the latter from the earth of alum, both dissolved in water impregnated with fixed air, the water filtrating very slowly through a porous bottom of baked clay. The description of
this

In the smelting of copper ores, quartz is used, to render the slag glassy, or to vitrify the iron ;
quartz

this apparatus invented by Mr. Achard, may be seen in the *Journal de Physique* for January, 1778. I shewed these crystals to the Assembly of the Royal Academy at Paris in the same year, and I still keep them by me, together with the letter in which they were inclosed. The process has been since attempted by myself, as well as by many others, though without the desired effect. This must be attributed to some unheeded circumstance that escaped the author, as I have not yet heard that he has been himself able to succeed a second time. *Edit.*

But although the attempts to repeat the formation of hard crystals by the method of Mr. Achard have been unsuccessful till this day, we cannot doubt of the solubility of siliceous earth in very hot water, as there is a very remarkable phenomenon of the kind which deserves to be noticed : and the more so, as we should be intirely ignorant what would be the event, had not Nature herself spontaneously assisted our ignorance and sloth, in the investigation of her powers.

At *Geyser* in Iceland there spouts up a hot water, which, upon cooling, deposits *siliceous* earth : and of this very matter a stinty basin or crater has been formed by itself, having 59 feet in diameter. This spout is of a stupendous bulk, as the opening through which it gushes out at various intervals has 19 feet in diameter : and sometimes it was observed by Dr. Van Troil to reach the height of 92 feet. though several affirm it has spouted to the hight of sixty fathoms. The heat of the water during its explosion cannot be ascertained ; but after it has been thrown through a stratum of air 90 feet thick, it rises still the thermometer to 212 degrees of Fahrenheit, which is still the utmost heat that water can hold in the open air. It is obvious therefore that siliceous earth may be dissolved in water, when it has a far greater degree of heat than that with which it boils. Perhaps such experiment may still succeed by employing a good Papin's digester : but I do not know that any such trial was ever executed with success. See the account of this phenomenon in Van Troil's *Letters on Iceland*, pag. 259, and in Professor Bergman's treatise de *Terra Silicea*. *Edit.*

This

quartz being more useful than any other stone to prevent the calcination of the metal.

The quartzose sand which constitutes part of many stones, and is also used in making crucibles, and such vessels, contributes most of all to their power of resisting fire.

It appears likewise probable that the quartzose matter makes the grind and whetstone fit for their intended purposes[g].

[g] This seems to be the most proper place to insert the Table in which Mr. Quist has shewn the comparative hardness of various substances, as those belonging to the silicious earths are more numerous on account of this property than those of the other kinds of earths. Mr. Quist determined the hardness of these substances, by observing the order in which they were able to cut and make an impression on each other; the first are able to cut or scratch the succeeding; but not *vice versa*. He added, the specific gravity of almost all the specimens he used. The *first column* shews the *hardness*: and the *second* their *specific gravity*. The last four species were added by Mr. Kirwan, after his own observation: and the specific gravities marked with a * were added by the Editor, chiefly from Professor Bergman. *The Edit.*

TABLE

TABLE of the comparative hardness of various mineral substances.

<i>Names.</i>	<i>Degree of hardness.</i>	<i>Specific gravity.</i>
Diamond from Ormus	20	3.7 *
Pink diamond	19	3.4
Bluish diamond	19	3.3
Yellowish diamond	19	3.3
Cubic diamond	18	3.2
Ruby	17	4.2
Pale Ruby from Brazil	16	3.5
Ruby Spinell	13	3.4
Deep blue Sapphire	16	3.8
Ditto paler	17	3.8
Topaz	15	4.2
Whitish ditto	14	3.5
Bohemian ditto	11	2.8
Emerald	12	2.8
Garnet	12	4.4
Agate	12	2.6
Onyx	12	2.6
Sardonyx	12	2.6
Occid. Amethyst	11	2.7
Crystal	11	2.6
Carnelian	11	2.7
Green Jasper	11	2.7
Reddish yellow ditto	9	2.6
Schoerl	10	3.6 *
Tourmaline	10	3.0
Quartz	10	2.7
Opal	10	2.6
Chrysolite	10	3.7
Zeolyte	8	2.1
Fluor	7	3.5 *
Calcareous Spar	6	2.7 *
Gypsum	5	2.3 *
Chalk	3	2.7 *

N. B. 1. Artificial gems are easily distinguished from the natural, by their softness, fusibility, solubility in acids, and in many cases by their specific gravity.

2. Stones whose hardness does not exceed 11, may be scratched with steel.

3. The opal mentioned in the Table, must be a Pseudo-opal of the kind mentioned in the Note to § 95, as Mr. Quist, in a letter to Mr. Rinman, mentions his having seen opal, nearly as hard as diamonds. *Edit. chiefly from Kirwan.*

ORDER THE FIFTH,
ARGILLACEOUS EARTHS.

S E C T. 129. (77.)

The Argillaceous Kind. *Argillæ*, Lat. *Leror*,
Swed. *Thon*, Germ. *Argilles*, French.

The principal character whereby these may be distinguished from other earths, is, that they harden in the fire, and are compounded of particles so disposed, that they exhibit a dead or dull appearance when broken [a].

Moreover

[a] By *argillaceous earth* is not meant common clay, which is never free from *siliceous* matter; but a pure clay, unmixed at least with any other earth. This may be readily obtained by dissolving Roman, or rock allum in distilled water, filtering and precipitating it by mild volatile alkali.

1. The specific gravity of this pure clay, or argill, is 1305.
2. It dissolves in acids, with a little effervescence. 3. With the vitriolic acid it forms *alum*: 4. but with the nitrous, muriatic, and vegetable acids it forms deliquescent salts.

5. When

Moreover, there are some of this order which grow soft in water, and, when only moistened, become ductile and tenacious; these are commonly called clays [b]. Some crack in water, after having imbibed a sufficient quantity of it, but do not grow softer in it, and are therefore in the first degree of induration; some imbibe the water, but do not crack or fall to pieces; these are yet more indurated: and finally, some

5. When dry it absorbs water greedily: becomes soft: 6. and, with a due quantity of water, acquires such a tenacity that it may be moulded at pleasure. 7. This mass contracts greatly in the fire, from whence arise numerous cracks: 8. and with a due degree of heat it becomes hard enough to strike fire with steel. 9. By thus burning, it loses its glutinous tenacity: and the water is excluded by the approach of its particles to one another: 10. nor does it again assume its former properties, but by a chemical process of solution and precipitation, &c. 11. It may be dissolved in the *dry way*, by means of fixed alkali, as well as in the *humid* by acids. The vitriolic acid is better than the others for this purpose, because it may be more easily concentrated.

12. Earth of alum, viz. pure argill, neither dissolves sulphur, nor decomposes sal ammoniac. *The Editor, from Bergman's Sciagraphia.*

[b] 13. The specific gravity of argill, when pure, does not exceed 2000. 14. It is exceedingly diffusible in water, though scarcely more soluble than pure magnesia. 15. It is combinable with acids, and when combined with the nitrous or marine it is separable, like magnesia, but scarcely precepitabile by the vitriolic acid with which it forms alum, a salt that always contains an excess of acid, and has an astringent taste. 16. When combined with any of these acids it is not precipitable by the acid of sugar, a criterion that distinguishes it from the other earths, all which (except the ponderous when united to the vitriolic acid and the siliceous, which is not acted on

Some there are, in which the water has no ingress at all.

Thus, by following the successive gradation of induration of a substance, which throughout all

by any acid hitherto known but the sparry) are precipitable from the vitriolic, nitrous, and marine acids, by that of sugar, though the precipitation is not always apparent before the liquors be evaporated, nor at all if there be an excess of the mineral acids. 17. The strongest heat barely hardens it, but does not give it the qualities of lime, while single or accompanied only with magnesia or silex; 18. but mixed with calcareous it runs into fusion very readily; and hence Mr. Gerhard has found it fusible in a crucible of chalk, but not in one of clay. 19. Fixed alkalis do not promote its fusion, but borax or microcosmic salt dissolves it, the first with scarce any, and the latter with a more notable effervescence. 20. Calces of lead affect it something less than they do calcareous earths. *Kirwan.*

Mr. Josiah Wedgwood, F. R. S. has constructed an ingenious thermometer for the admeasurement of the higher degrees of heat upon the above 7th property of Argill. He has observed that the contraction of baked clay increases accordingly as the heat to which it is exposed is greater. He therefore proposes a number of small bricks of a native clay of considerable purity, found in Cornwall, which after a slight hardening are cut by an instrument, so that their dimensions are respectively equal to a great degree of accuracy. Each of these small bricks is *five tenths* of an inch in breadth, with the sides exactly parallel, this being the dimension intended to be measured; about *four tenths* of an inch deep and *one* inch long.

Some of these bricks being placed in the fire whose heat is required to be found, become ignited in a very short time. The brick is then taken out and suffered to cool, or cooled by immersion in water, no difference being observed to arise from this sudden refrigeration. When cool it is suffered to slide gently down an inclined plane of brass, between two upright graduated strait rules of the same metal, that are inclined to each other in a very small angle. This brass gage or scale is *24 inches* long with the two side-pieces exactly strait divided into *inches*.

all these circumstances is easily discovered to be the same, one may with great reason conclude, that the hardness of the jasper may perhaps

inches and tenths; fixed five tenths of an inch asunder at one end, and three tenths at the other, upon the brass flat plate above mentioned; so that one of the thermometric pieces of clay, when pared down on the cutting mould of metal, will just fit the wider end of the gage. These small bricks are dried, and afterwards baked with a low red-heat, to give them a proper firmness, that they may bear package and carriage. It is evident that if any of these bricks diminishes one tenth in breadth, it will then pass to one half of the above scale: and if two tenths, it will go on to the narrowest end.

As a scale of two feet long may appear inconvenient, it may be divided into two parts, the first and second side-pieces being fixed 5 tenths asunder on the plate, at one end; and 4 tenths at the other: and the third piece at the same distance of *four tenths* at one end, and *three tenths* at the other.

The operator, in using this new thermometer, must be careful to expose its bricks to an equal action of the fire with the body whose heat he wants to measure by them. In three minutes time they receive the full contraction which that degree of heat is capable of producing: and it is remarkable that strong degrees of heat are communicated to them with greater celerity than weaker degrees: perhaps the heat is more readily transmitted, in proportion as the texture of the clay becomes more compact.

By a chemical analysis, this kind of porcelain clay from Cornwall, has been found to contain three parts of pure *argillaceous* or *aluminous earth*, and two only of pure *silicious earth*. See *Phil. Trans.* part 2. for 1782.

A paper was lately read at a meeting of the Royal Society, containing the further steps taken by the same ingenious gentleman for carrying the scale of Fahrenheit's thermometer up to that of his new one, by means of intermediate substances, which should connect the upper extremity of the one with the lower degree of the other. This was at last obtained with great nicety, as will be seen in that paper, which, it is hoped,

haps be the last degree of hardness, and that this stone consequently consists of an argillaceous substance, (Sect. 107.) that already possesses a quality

will be printed in the Philosophical Transactions for the present year, 1784. In the mean while it will be sufficient in this place to announce that each degree of his thermometer is equal to 130 degrees of Fahrenheit's thermometer: and by a proper calculation the following table was made, shewing the correspondence, or value of the degrees of each thermometer, answering to one another.

Degrees of Heat expressed by the two Thermometers.

<i>Wedg-wood's,</i>	<i>Fahren-heit's.</i>	<i>Phenomena already observed.</i>
240	= 32277	greatest heat of Mr. Wedgwood's furnace.
160	= 21877	Heat of his small air-furnace.
130	= 17977	Cast iron melts.
125	= 17327	Heat of a common smith's forge.
95	= 13427	the greatest welding heat of iron.
90	= 12777	least ditto.
32	= 5237	fine gold melts.
28	= 4717	fine silver melts.
27	= 4587	Swedish copper melts.
21	= 3807	Brass melts.
6	= 1857	enamel colours melt.
0	= 1077	red heat visible by day light.
-1	= 947	red heat visible in the dark,
-3,673	= 600	Mercury boils.
-6,658	= 212	water boils.
-7,542	= 97	vital heat.
-8,142	= 32	water freezes.
-8,289	= 0	proof spirit freezes.
-8,596	= -40	Mercury freezes.

N. B. It appears by the above, that from the freezing point to that of vital heat, is hardly $\frac{1}{100}$ part of the whole scale in our globe: how far extended that of the inhabitants of

lity which the other clays cannot acquire but in the fire; having, besides, the same effect as the less ferrugineous boles, when melted in the fire together with calcareous or other earths.

S E C T. 130. (Additional.)

Argilla aerata, Lac Lunae.

A. This fanciful name was heretofore thought to denote a very fine species of calcareous earth (Sect. 5.); but Mr. Schreber has lately shewn that the earth to which this name is given, is a very uncommon species of argill. It is generally found in small cakes of the hardness of chalk: and like that, it marks white. Its hardness is nearly as that of steatites, and it does not feel so fat as common clay does. Its specific gravity is 1669: its colour snow white. When examined with a microscope, it is found to consist of small transparent crystals; and by his experiments, it appears plainly to be an argill saturated with fixed air. It effervesces with acids and contains a very small proportion of calca-

of other planets may be, from the remotest Herschel's planet to that of Mercury, the nearest neighbour of the Sun, is, I apprehend, out of the reach of the human mind to decide.
The Editor.

reous earth and sometimes of gypsum, besides some feeble traces of iron [c]. It is found near Halles. (15 *Naturforsch.*, 209, quoted by Mr. Kirwan.)

S E C T. 131. (78.)

B. Porcelain Clay, Terra Porcellanea, vulgò Argilla Apyra. (The *Kaolin* of the Chinese.)

It is very refractory in the fire, and cannot in any common strong fire be brought into fusion any farther than to acquire a tenaceous softness, without losing its form: it becomes then of a dim shining appearance and solid texture, when it is broke; strikes fire with steel; and has consequently the best qualities required, in a substance whereof vessels capable of resisting a melting and boiling heat, and of holding salts and acids, may be made. It is found,

1. Pure.
- A. Diffusible in water,
1. Coherent and dry,

[c] Whether the *Lac lunæ* of Sect. 5, be the same with the substance here described or not, I do not pretend to determine: at least I do not see any reason why the same name of *Lac lunæ* might not have been given to two substances apparently alike, one of the *calcareous*, and other of the *argillaceous* kind. See Note [w] to Sect. 5. The Editor.

a. White

a. White, from Japan.

I have seen a root of a tree changed into this clay, (Appendix, Section 283 of the Author).

2. Friable and lean.

White, is found in clefts of rocks at Westerfilsverberget in Westmanland and between the coal in the coal-pits at Boserup in the province of Skone [*d*].

[*d*] These may be called pure clays, since after being burnt they are quite white, though they have been exposed to a quick melting heat; and it may be queried, whether all such clays must not be somewhat harsh, or at least not unctuous to the touch. *The Author.*

We must be aware of the difference between the pipe clay, mentioned in the following Section, of which kind we have plenty in Devonshire, and that clay which is used in the manufactures of porcelain. The former, in an open fire, burns to a bluish grey, or pigeon colour: but the latter remains white. See Note *f* in the following page 234. The former seems to be the same as the Cologne and Maestricht pipe clay of the next section: but the latter seems to be but a decayed felt spar: and consequently, according to Bergman (Sect 130 of his *Sciagraphia*) contains *magnesian earth*. It is chiefly from these mixtures that those various properties mentioned by the Noble author in Sect. 129 proceed. Our porcelain clay contains, likewise, *quartz crystals* and *mica* mixed with it, parts of the granite which it originally composed. Before it is used, the *quartz* is separated; but the *mica* remains, according to the observation of Mr. James Watt to Doctor Withering. See the *English Edition of the Sciagraphia*. Sect. 113. p. 54. *The Editor.*

S E C T. 132. (78.)

C. Combined with phlogiston. *Terra porcellanea phlogisto aliisque heterogeneis minima portione mixta [e].*

Diffusible in water.

a. White and fat pipe clay, from Cologne and Maestricht (called *colnisch* or *pipe clay*.)

Less unctuous is found in small fissures in a vein of *lapis ollaris*, at Swartwik, in the parish of Swerdsio, in the province of Dalarne [f].

b. Of a pearl colour, from Maestricht.

c. Bluish grey, *La belle terre glaise* from Montmartre, near Paris in France.

d. Grey, from France, Hesse, Bosempin, Skone.

e. Black, *La terre noire*, at Montmartre.

f. Violet, also from Montmartre [g].

S E C T.

[e] With *sulphur*. Such is the aluminous earth from *Tolfa* in Italy, according to Monet: it appears like chalk, and has a sensible flavour, before it is calcined. *Fabroni*.

[f] Many of these clays become grey in a weak degree of heat, because the mineral oil with which they are mixed, burns to a kind of coal and tinges them: but in a stronger heat they again become white, this coal being consumed. *Kirwan*.

[g] These *clays* contain a phlogiston, which is discovered by exposing them to a quick and strong fire, in which they become quite black internally, assuming the appearance of common flints, not only in regard to colour, but also in regard to hardness:

S E C T. 133. (84.)

D. Stone Marrow, *Lithomarga*: I have given this name to a kind of clay which,

1. When dry, is as fat and slippery as soap : but,
2. Is not wholly diffusible in water, in which it only falls to pieces, either in larger masses, or in such a manner as to assume the appearance of curds.

hardness: but if heated by degrees, they are first white and afterwards of a pearl colour. The fatter they seem to be, which may be judged both by their feeling smooth and unctuous, and by their shining when scraped with the nail, they contain a larger quantity of the inflammable principle.

It is difficult to determine, whether this strongly adherent phlogiston is the cause of the abovementioned pearl colour, or prevents them from being burnt white in a strong fire: yet no heterogeneous substance can be extracted from them except sand, which may be separated from some by means of water, but which sand does not make out any of the constituent parts of clays.

If they be boiled in *aqua regis*, in order to extract any iron, they are found to lose their viscosity.

In the less unctuous clays I have found pure quartz in greater and smaller grains; but still I would not venture to assert, that one is produced from the other according to the rule I have laid down in *sect. 1. page 9.*

I have found likewise that this sort, upon certain occasions, attracts phlogiston in the fire.

These remarks may serve as hints for the less-experienced, who have a mind to examine those clays, which are of so great consequence on account of their œconomical uses. *Author.*

3. In the fire it easily melts to a white or reddish frothy slag, which in consequence of its internal vacuities is then of a larger volume than it originally was.

4. It breaks into Irregular scaly pieces.

A. Of coarse particles: coarse stone marrow.

a. Grey, from Osmundsberget, in the parish of Rettwik, in Dalarne, and is there called *Walklera*, that is, fullers earth. It is mentioned in an account of Osmundsberget, published in the Transactions of the Academy of Sciences at Stockholm, in the year 1739, by the Berg's-radet, or mine-master, Mr. Tilas.

b. Whitish yellow, from the Crim Tartary, where it is called *Keffekil*: (see Sect 56): and it is said to be used for washing instead of soap [b].

B. Of very fine particles; fine Stone Marrow.

a. Yellowish brown, *Terra Lemnia* [i].

It

[b] This kind of earth is found also, and used likewise by the country people for washing, instead of soap, in the Barony of Hierges, near Niverlè, belonging to his Highness the Duke of Arenberg, in the Austrian Flanders. His Chancellor, who by the uprightness of his behaviour has obtained the honourable surname of *Jean De bien*, shewed me various specimens of this earth, which he affirmed to be only found in separate masses: but it is probable that some considerable strata of it may be found, if properly searched for on the spot, by digging the ground to a considerable depth. *Editor.*

[i] This is a compound of the argillaceous, siliceous, and magnesian earths. Its component parts are the same as those of the talc, but looser, and in different doses. *Berg. Sciag.* §. 116.

The

It is of a shining texture, and falls to pieces in the water with a crackling noise; and is more indurated than the foregoing, but has the same qualities in other respects [j].

SECT.

The *terra lemnia* cannot properly be called a *fuller's earth*, since it neither is of that kind used in the fulling business, nor is likely to be applicable to it. It is, besides, a very scarce clay. It is not found indurated, so far as I know; and if it should at any time be discovered, it will be necessary to examine, whether it is not a Zeolites, or at least very nearly approaching to it, in regard to the effects both undergo in the fire. *The Author.*

As the best sort of Fuller's Earth did not come into our Author's hands, it is no wonder that he excludes it from its due place. The true Fuller's Earth of England is exactly like the stone marrow in all the abovementioned properties; and in regard to the texture and colour, it comes nearest to the above described coarse stone marrow. *Engest.*

[j] *Terra Lemnia* is so called from the island Lemnos now Statimane in the Egean sea, from whence it is procured. It is likewise called the *Turkish earth*, on account of its being impressed with the seal of the Grand Signior. It is of a luteous colour.

The Osmundian Argilla is found in the mountain Osmund at Ratwick in East Dalecarlia. The stratum is three feet thick, and the mountain itself is chiefly calcareous. This is harder, and of finer particles than the Lemnian earth, and is of an ash colour.

The Hampshire fuller's earth is of a dusky brown inclining to green, with veins of faint yellow. It contains a small portion of muriatic acid, and an oily and volatile matter.

These substances are akin to zeolites, and likewise resemble some marles. But in the Osmundian earths, the connection of the parts is not merely mechanical as in marles, which on that account effervesce strongly with acids, though they often contain a less quantity of calcareous earth or magnesia, than the lithomarga here mentioned.

Every

S E C T. 134. (85.)

E. Bole, (Iron Clay.) Bolus.

Is a fine and dense clay of various colours, containing a great quantity of iron, which makes it impossible to know the natural and specifical qualities of the bole itself, by any easy method hitherto in use. It is not easily softened in water, when indurated, as the porcelain and the

Every fine clay that does not communicate a colour, is in general proper for the business of fulling. Even hog's excrements mixed with human urine, are used instead of fuller's earth in various woolen manufactures.

The properties required in a good *fuller's earth* are that it shall carry off the oily impurities of the woolen cloth, and at the same time thicken it by causing the hairs or fibres to curl up. The finest siliceous earth with argilla and a little calcareous earth without the vitriolic acid, constitute the best fuller's earth. A little martial calx is not noxious, if no active menstruum be present, as is evinced in the *Argilla Hampshirensis*, which is an excellent fuller's earth.

The following table exhibits the component parts of the three substances just mentioned.

A Centenary of <i>Argilla lemnia.</i> <i>Osmundica.</i> <i>Hampshirensis.</i>			
contain			
Siliceous earth	47.0	60.0	51.8
Chalk or calx aerata	5.4	5.7	3.3
Magnesia aerata	6.2	0.5	0.7
Argilla	19.0	11.1	25.0
Calx of iron	5.4	4.7	3.7
Water or volatile matter	17.0	18.0	15.5

The Editor from Bergman's Treatise de Analyfi Lithomargæ. commun

common clays are, but either falls to pieces in form of small grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the load-stone [k].

S E C T. 135. (86.)

A. Loose and friable boles, or those which fall to a powder in water.

a. Flesh-coloured bole, from Kristiersberg, at Nya Kopparberg in Westmanland.

b. Red.

1. Fine, *Bolus Armenus*.

[k] Bole is a term of uncertain signification, and should therefore be banished from common use, and still more from Mineralogical Treatises. Some bestow this name on very smooth compact clays, consisting of the finest particles: others require besides, that their colour should be red, yellow, or brown, and that they should contain iron. The red generally blacken in the fire; yet, according to Rinman, they do not become magnetic. The yellow, when heated, become first red: and in a strong heat, brown or black.

What the Italians call *calamita bianca*, is a white bole, striated like asbestos, according to Ferber.

The true *sigillata rubra* contains calcareous earth, and according to Rinman it becomes magnetic, after torrefaction.

The yellow, red, and brown clays contain most iron, sometimes dispersed through them, and sometimes united to the siliceous part: in this case they are more difficultly fusible. The *yellow calx of iron* is more dephlogisticated than the *red*: and the *red* more so than the *brown*. When these clays contain about 14 or 15 per cent. of iron, they become magnetic after calcination. *Editor, from Kirwan.*

2. Coarse

2. Coarse, *Bolus communis officinalis*, from the sand-stone quarries at Orsa, in the province of Dalarne.

3. Hard, *Terra rubrica*, (the red pencil.)

c. Green, *Terre verte*.

1. Fine, from Italy.

2. Coarse, from Stenstorp, in the province of Westergottland.

d. Bluish grey, from Stollberget, in Kopparbergslän, in Sweden.

Is ductile as long as it is in the rocks, but even then repels the water: it contains forty per cent. of iron; which metal being melted out of it in a close vessel, crystallises on its surface.

e. Grey.

1. Crystallised in a spherical polygonal figure: from Swappawari, in Lapland.

2. Of an undetermined figure, from Grengerberget in Westmanland [1].

SECT.

[1] At the time when the *terrae figillatae*, or sealed earths, were in general use, the druggists endeavoured to have them of all colours; and for that reason they took all sorts of clays and sealed them; not only the natural ones, but likewise such as had been coloured by art, or had been mixed with *magnesia alba officinalis*, or other things, were afterwards vended for true boles; and for this reason the species of boles is still thought to comprehend so many varieties. Thus the Cologne clay (Sect. 132.) is by the druggists ranked among the white sealed earths, and is called a *white bole*: this same clay is by the Swedish potters called *Englesk jord*, or English earth; and by the tobacco-pipe makers, *Pip-lera* or pipe clay, &c. which shews how great a confusion there must ensue,

if

S E C T. 136. (87.)

B. Indurated Bole, *Bolus indurata*.

A. Of no visible particles, *Particulis impalpabilibus* [m].

This occurs very often in form of slate, or layers in the earth, and then is called *flitsmalm*, when used as an iron ore. However, it has usually been considered more in regard to its texture, than to its constituent parts, and has been called *slate*, in common with several other earths, which are found to have the same texture.

a. Reddish brown from England [n].

b. Grey, from Coalbrookdale, in Shropshire, and most collieries of England [o].

if the knowledge of these bodies was not founded upon a surer ground than the colour, figure, and names invented by common mechanics. Since the most part of these *terreæ sigillatæ*, or sealed earths, are found to contain iron, I conclude, that the bole must be a martial clay; and, as such, it seems to be more fit for medical uses than other clays, if any dead earth must be used internally, when there is such an abundance of finer substances. *Author*.

[m] It is a true clay united to siliceous and martial earths. Berg. Sciag. § 114.

[n] In most collieries between the seams of coal, as at Hannam, in Kingswood, near Bristol, Blanavon, in Monmouthshire, &c. D. C.

[o] This bole is found frequently in pieces like nuts, of different sizes, that exhibit impressions of plants, when broken in two; in the same manner as the nodules of copper slate from Ilmenau contain fish. *Brun*.

S E C T. 137. (88.)

F. Of scaly particles, *Particulis squamosis*: The hornblende of the Swedes [*p*].

It is distinguished from the martial glimmer or mica (Sect. 65.) by the scales being less shining, thicker, and rectangular.

a. Black. This, when rubbed fine, gives a green powder [*q*].

b. Green-

[*p*] The hornblende grows hard in the fire, which is the reason why it is ranked here among the clays, though in all its other qualities it much resembles the cockle or shirl (Sect. 119) *Engestr.* This kind Wallerius calls horn-rockstone (hornfels steen) and places it among the apyrous stones; but Linnæus has put it among the calcareous stones, by the name of horn-slag, *talcum corneum*. Brun.

The general character of this stone, which Rinman calls *Talcum striatum*, besides a partial solubility (though without effervescence in acids and such a hardness never sufficient to strike fire with steel, properties which are common to it with the preceding species) are,

1st. a specific gravity never less than 2660, and frequently rising to 3880.

2d. A strong earthy smell, which it exhales on being breathed upon, or having hot water poured on it.

3d. A toughness and viscosity perceived in pounding it in a mortar, like *mica* or *horn*, from which last is derived its name.

4th. Its affording a greenish grey powder, when pounded.

5th. Its being fusible *per se*, as it is said, though Mr. Kirwan acknowledges that he never could melt this stone with a blow-pipe. N. B. The horn-stone is frequently mixed with pyrites. *The Editor from Kirwan.*

[*q*] This is the *Corneus nitens* of Wallerius.

Its texture is either lamellated, or granular. The former is sometimes so soft, as to be scraped with the nail.

Its surface is frequently as glossy as if it had been greased.

Its specific gravity is from 2600 to 3880.

It

b. Greenish[r].

Both these, particularly the black, are found every where in Sweden among the iron ores, and in the Grönsten (*in the Appendix.*)

It possesses, besides, all the specific properties abovementioned in the preceding section in a high degree.

It does not detonate with nitre.

When heated, it becomes of a snuff colour.

And then slightly effervesces with diluted nitrous acid.

Its solution in this acid, the nitrous, is of a greenish colour.

In order to discover the principle on which the smell of this stone depends, Mr. Kirwan boiled its powder in water; but did not find the water altered in taste, nor did any test he applied, shew any change in it.

The lamellar sort contains in an hundred, 37 parts of *silica* 22 of *argill*, 16 of *magnesia*, 2 of *calcareous* earth, both in a mild state: and 23 of *calx of iron*, not much dephlogisticated.

Kirwan.

[r] This is of a granular texture, or striated.

The specific gravity of a specimen of the present sort examined by Mr. Kirwan, was 2683.

It is not so soft as the softest horn stone of the preceding Sections.

It seems that the common pale greenish grey whetstone belongs to this species.

It is of a close granular texture.

Exhales an earthy smell.

Affords a greenish powder.

Does not effervesce with acids;

Nor gives fire with steel.

Its specific gravity is 2664.

And contains 65 per cent. of *siliceous* earth. Kirwan.

S E C T. 138. (108.)

Zeolyte. *Zeolythus* [t].

G. This is described in its indurated state in the Transactions of the Academy of Sciences at Stockholm, for the year 1756, and there methodised as a stone *sui generis*, in regard to the following qualities [t].

1. It

[s] The noble author was the first who made this kind of mineral substances known to the world: and classed them as a distinct species from any other, in the eighth order of earths of this Mineralogy. But, after their true component parts were discovered by a proper chymical analysis, Professor Bergman and Mr. Kirwan have both ranged these substances among the *argillaceous* earths, on account, as it seems, of their soft texture and greasy feel, notwithstanding that the *Siliceous* earth has been found to be the most predominant in their composition. By a similar motive, precious stones have been ranged among the *siliceous* earths, on account of their hardness, although the *Argillaceous* be the most predominant in their composition. (See Note [c] page 162.) In fact it is not so much the quantity, as the intensity, or predominancy of property that should in general direct us in the classification of mineral bodies: not to mention, that if the rule respecting quantity were rigorously adhered to, the two primitive earths, *argill* and *magnesia*, would not be found among the earths, which would doubtless be an absurdity, as Bergman has rightly observed in his *Sciagraphia*, Sect. 16. *The Editor*.

[t] Mons. Bayen believes that zeolites is composed of argillaceous and siliceous earth in equal parts. And the same results appeared by the analysis of Mr. Guettard. *Fabroni*.

But,

1. It is a little harder than the fluors, and the other calcareous spars; it receives however scratches from the steel, but does not strike fire with it [*u*].
2. It melts easily by itself in the fire, with a like ebullition as borax does, into a white frothy slag, which cannot without great difficulty be brought to a solidity, and transparency.
3. It is more easily dissolved in the fire by the mineral alcali (*sal sodæ*) [*v*], than by borax or the microcosmic salt.

But, according to Bergman's analysis, the red zeolyte of *Adelfors* contains 80 per cent. of *siliceous* earth: 9, 5 of *argillaceous*: 6, 5 of *pure calcareous* earth: and 4 of *water*. The white oval radiated zeolyte of *Feroe* in Iceland, contains, according to Mr. Pelletier, 50 of *silice*: 20 of *argil*: 8 of *pure calcareous* earth: and 22 of *water*. Mr. Meyer found another of the radiated sort to contain 58,33 per cent. of *silice*: 17,5 of *argill*: 6,66 of *lime*: and 17,5 of *water*. In general the crystallized sort contains more water than the amorphous zeolytes. Those of *Femland* contain 16 per cent. of *calcareous* earth: and that of *Feroe* contains 25 per cent. of *argill*: so that the proportions are very variable: but it is evident that the *siliceous* earth is the predominant among the component parts. *Edit.*

[*u*] Generally they are of a crystalline form, composed of imperfect pyramids, turned towards a common centre. They are sometimes globular: and seldom in a prismatic form. *Brun.*

Messrs. Faujas and Romé de L'Isle mention various zeolites of a cubic and other forms, found in Iceland, in the Cyclops islands, near Etna in Sicily; in the island of Bourbon, &c. *Edit.*

The specific gravity of the zeolytes is from 2100 to 3150; but this last is very rare. *Kirwan.*

[*v*] By which a great ebullition is made, without being totally dissolved. *Fabr.*

4. It does not ferment with this last salt, as lime does [w]; nor with the borax, as those of the gypseous kind.
5. It dissolves very slowly, and without any effervescence, in acids, as in oil of vitriol and spirit of nitre. If concentrated oil of vitriol be poured on pounded zeolites, a heat arises, and the powder unites into a mass [x].
6. In the very moment of fusion it gives a phosphoric light [y].

S E C T. 139. (109.)

The zeolyte is found in an indurated state.

1. Solid, or of no visible particles, *Zeolites solidus particulis impalpabilibus, figuræ indeterminatæ*.

A. Pure, Zeolythus Purus.

- a. White, from Feroe, in Iceland; it has the appearance of a cacholong [y*].

B. Mixed with silver and iron.

[w] But swells, and dissolves, though slowly, with it. *Fabr.*

[x] Since the publication of this Essay, there have been discovered more varieties of the zeolites, particularly at Adelfors's gold-mines in Smoland in Sweden, of which some sorts do not melt by themselves in the fire, but dissolve readily in the acid of nitre, and are turned by it into a firm jelly. *Engest.*

[y] Distilled with nitrous acid it produces fixed air (or aerial acid) and some dephlogisticated air. *Fabr.* from *Priesley*.

[y*] b. Zeolite half transparent from Garphyttan: which has an electric power. *Fabroni.*

a. Blue

a. Blue, *Lapis lazuli*, from the Buckarian Calmucks [z].

This, by experiments made with it, has discovered the following properties.

1. It retains for a long time its blue in a calcining heat, but is at last changed into a brown colour.
2. It melts easily in the fire to a white frothy slag; which, when exposed to the flame of a blow-pipe, is greatly puffed up; but in a covered vessel, and with a stronger heat, becomes clear and solid, with blue clouds in it.
3. It does not ferment with acids: but,
4. Boiled in the oil of vitriol, it dissolves slowly and loses its blue colour.

When a fixed alkali is added to this solution, a white earth is precipitated, which being scorified with borax, yields a silver regulus, that varies in bigness, according to the various samples of the stone.

5. By scorification with lead, there has been extracted two ounces of silver out of one hundred pounds weight of this stone.
6. The presence of silver is not discovered with the same certainty by the spirit of nitre, as by the oil of vitriol.

[z] Its specific gravity is hardly above 2100. *Berg.* The lapis lazuli, called by the fanciful name of *Oriental*, is of a fine blue colour inclining to purple: that of a pale blue is not so much esteemed. It is often variegated with yellow and white shining veins and speckles, which the common people think to be true gold and silver, though in reality they are nothing else but martial marcasites. *Edit.*

7. When the spirit of sal ammoniac is added to any solution, made either of crude, or of a perfectly calcined lapis lazuli, there is no blue colour produced; which proves that this colour is not owing to copper, as some have pretended: and this is farther confirmed by the fixity of the blue colour in the fire (1, 2.), and by the colour of the slag or glass (2.).
8. It is a little harder than the other kinds of zeolites; but does not, however, in hardness approach to the quartz, or to other stones of the siliceous kind in general; because the purest and finest blue lapis lazuli may be rubbed with the steel to a white powder, although it takes a polish like marble [a].
9. The lapis lazuli, when perfectly calcined, is a little attracted by the load-stone; and scorified with lead, the slag becomes of a greenish colour, not such a colour as copper gives, but such as is always produced by iron mixed with a calcareous substance [b].

SECT.

[a] Some of its parts however strike fire with steel. *Mongez.*

[b] The lapis lazuli is seldom found pure, but is most generally full of veins of quartz, limestone, and marcasite: however, for these experiments none but the purest pieces have been picked, such as have been examined through a magnifying-glass, and been judged as free from heterogeneous mixture as possible. It is to be wished, that those who have a sufficient quantity of this stone would continue these experiments, in order to discover what substance it is that makes this blue colour, which is so constant in the fire, since it cannot depend either on copper or iron; for though those metals,

on

S E C T. 140. (110.)

2. Sparry Zeolites, *Zeolites spatiosus*.

This resembles a calcareous spar, though it is of a more irregular figure, and is more brittle.

on certain occasions, give a blue colour, yet they never produce any other but what instantly vanishes in the fire, and is destroyed by means of an alkali. What is mentioned in several books about the preparation of the ultramarine from silver, can by no means be objected here; since in those processes the silver employed is mixed with copper, and other substances, which contain a volatile alkali, whereby the blue colour is produced.

In regard to the above-mentioned qualities of this stone, it cannot be classed under any other kind of earths than this (the zeolites). *The Author*.

Mr. Margraf has since, in his Chemical Dissertations, printed in German. in the year 1761, published some experiments on the lapis lazuli: and in the chief particularly agrees with our author, without, however, knowing any thing of these his experiments. Mr. Margraf also proves that there is no copper in this stone; and besides tells us that he hath found both a calcareous and a gypseous substance in it, although he took care to pick out only the very pure bits for his experiments. However, I am led to imagine, that the calcareous substance is not essential to the existence of the lapis lazuli, since Mr. Cronstedt expressly says, that the stone he tried did not ferment at all with acids. He farther mentions this remarkable circumstance, which makes it still more evident that the lapis lazuli belongs to the zeolites, viz. that when calcined and dissolved in the acids of vitriol, of common salt, or of nitre, it turned all those acids into a jelly. However, he does not take any notice of its containing silver, because he did not prosecute his experiments so far on that point; but some of his experiments, nevertheless, seem to indicate, as if all sorts of lapis lazuli did not contain silver. *Eng.*

a. Light

- a.* Light red, or orange-coloured, from Nya Krongrufvan, one of the gold-mines at Adelfors, in the province of Smoland.

S E C T. 141. (111.)

3. Crystallised Zeolites, *Zeolites crystallisatus*.
Is more common than the two preceding kinds, and is found,

A. In groupes of crystals, in form of balls, and with concentrical points, *Crystalli zeolitis pyramidales concreti ad centrum tendentes*.

a. Yellow, from Swappawari, in Tornea in Lapland.

b. White, from Gustavsgrufvan, in the province of Jemptland.

B. Prismatical and truncated crystals, *Crystalli zeolitis distincti figura prismatica truncata*.

a. White, from Gustavsgrufvan in Jemmland.

C. Capillary crystals, *Crystalli zeolitis capillares*.

Are partly united in groupes, and partly separate. In this latter accretion they resemble the capillary, or feather silver ore; and is, perhaps, sometimes called *Flos ferri*, at places where the nature of that kind of stone is not yet fully known.

These crystals are found,

a. White,

a. White, from Gustavsfgrufvan in Jemtland [c].

S E C T. 142. (112.)

Observation on Zeolites.

This kind of stone has nearly the same qualities in the fire as the boles; so that both of them, when more nicely examined, may perhaps be found to belong to the same order, and perhaps be some kind of earth whose properties have been long and perfectly known.

The *terra porcellanea Luneburgica*, which Bruckman mentions, and Mr. Wallerius has ranked among the gypsa, may, perhaps, belong to this order: but I have not been able to procure a specimen of it, to compare it with the zeolites, which also is very scarce, not being found in our country except in very small veins and cavities. To this scarcity is owing, that it has not yet been tried in the fire together with other kinds, except with the sparry fluor. With that it does not fuse very readily, because, when equal parts of them are melted together, an

[c] The zeolites have here in the North, the same country with the chalcedony and casholong. Pieces are shewn here as curiosities, where the zeolite is inclosed in the chalcedony: but this is insufficient to prove that the former arose from the latter, or *vice versa*. Brun.

opaque flag or glass is produced of the same colour with the alcali of nitre, of a fibrous texture, and of an uneven surface.

The quality of swelling in the fire, like the borax, is peculiar to the crystalised (Sect. 141), because the other varieties rise only in some small blisters, which are of a white colour at their edges, and instantly cover themselves with a white glassy skin, after which they become quite refractory [*d*].

[*d*] The zeolites have great affinity to the shoerls; but their component parts are not so strongly connected as to hinder the action of acids, which can destroy their combination without being previously treated with the fixed alkali; this last being a necessary requisite which must precede the analysis of shoerls. *Berg. Sciag.*

Mr. Pazumot thinks that the zeolites cannot be a volcanic production, but only a secondary production formed by the decomposition of volcanic earths. Certainly pure basalt, and volcanic lavas have the same component parts as those of the zeolites: and these last have not yet been found but among volcanic matters; but, as Mr. Faujas observes, there are many instances of the true zeolites being quite buried within the bodies of solid basalt, some being only fragments of zeolites, and some having a complete form; which prove that they have been already formed, before these volcanic masses were produced by subterraneous fires. *The Editor.*

S E C T. 143. (89.)

Tripoli, *Terra Tripolitana*[e].

H. Is known by its quality of rubbing or wearing hard bodies, and making their surfaces to shine,

[e] This earth was formerly brought to us from Tripoli in Barbary, from whence this name was given to it.

1. This earth does not effervesce with any of the acids; and
2. Becomes not only *hard* in the fire; but when considerable heat is applied, its surface becomes vitrified.
3. All Tripolis, except those found in England, obtain a red colour by being burnt.
4. They are fusible with the calcareous earth, as well as with the borax, and with the microcosmic sal. But
5. When washed in water, no other substance separates from them. However
6. Sometimes the marine acid and the vitriolic may be extracted by distillation from these earths.
 1. Solid: of a rough texture.
 - a. Brown.
 - b. Yellowish.
 - c. Spotted like marble.
 2. Friable and compact.
 - a. Granulated.
 - b. Brown.
 - c. Yellowish.

It is this last sort which is found in England. *Fabroni*.

I have procured that kind of yellow Tripoli mentioned by the author, from Scotland, where it had lately been discovered. But the *rotten stone*, so called, is another sort, found in England, viz. Derbyshire. It is in common used here among workmen for all sorts of finer grinding and polishing, and is also sometimes used by lapidaries for cutting of stones, &c. D. C.

The rotten stone of Derbyshire is, according to Ferber, a Tripoli mixed with calcareous earth.

Tripoli

shine, the particles of the Tripoli being so fine, as to leave even no perceprible scratches on the surface. This effect, which is called polishing, may likewise be effected by other fine clays, when they have been burnt a little. The Tripoli grows somewhat harder in the fire, and is very refractory: it is with difficulty dissolved by borax, and with still greater difficulty by the microcosmic salt: it becomes white by ignition: when crude, it imbibes water, but is not diffusible in it. It tastes like common chalk, and is rough or sandy between the teeth, although no sand can by any means be separated from it. It has no quality in common with other kind of earths by which it might be considered as a variety of any other. That which is here described is of a yellow colour, and is sold by druggists, who do not know where it is found.

S E C T. 144. (90.)

I. Common clay, or brick clay, *Argilla communis vulgaris plastica*.

This kind may be distinguished from the other clays, by the following qualities;

Tripoli is evidently a volcanic product. For a coal mine at St. Etienne having accidentally taken fire, and the fire in its progress having extended to some strata of shistus, and bitumen, Tripoli was found in those parts of the strata that the fire had acted upon, but not in any other *Mem. Par.* 1769, p. 276, quoted by Kirwan.

Tripoli is found also of grey, white, and red colour. It contains 90 parts of siliceous earth, 7 of argill, and 3 of iron. Some times a little of magnesia has been extracted from it.

1. In

1. In the fire it acquires a red colour, more or less deep.
2. It melts pretty easily into a greenish glass.
3. It contains a small quantity of iron and of the vitriolic acid, by which the preceding effects are produced [*f*]. It is found,

A. Diffusible in water.

1. Pure.

- a. Red clay, from Kinnekulle, in the province of Westergottland.
- b. Flesh coloured, or pale red, is found on the plains between Westeras and Sala, in the province of Westmanland.
- c. Grey, in the corn-fields in the province of Upland.
- d. Blue, is very common in Sweden, in the provinces bordering upon the Baltic.
- e. White, is found in the woody parts of Sodermanland, Dalarne, and other provinces. It is often found in a flaty form, with fine sand between its strata. It does not cake well together in the fire. When it is burnt, it is of a pale colour, and is more fusible than the preceding ones.

f. Fermenting clay, *Argilla intumescens*.

This is very like the preceding (*e*), as to the external appearance and other qualities; but when they are both found in the same place, which are not uncommon in several of our mine countries, they seem to be different in regard to the fermenting quality of this variety.

[*f*] It is also a compound of pure clay, siliceous and martial earth. *Beig. Sciag.*

This fermentation cannot be the effect of the sand mixed with it, because sand is found in them both: and besides, this kind ferments in the same manner when it is mixed with gravel or stones; and then it ferments later in the spring than the other, since by the stones, perhaps, the frost is longer retained in it.

2. Mixed with lime. See *Marle*, Sect. 30.

S E C T. 145. (91.)

B. Indurated.

1. Pure.

a. Grey slatey.

b. Red slaty, from Kinnekulle, in the province of Westergottland.

2. Mixed with phlogiston, and a large portion of the vitriolic acid. See *Alum ores*, Sect. 124 of the Author.

3. Mixed with lime. See *Lime*, Sect. 33.

S E C T. 146. (Additional, from Kirwan.)

Argillaceous fissile stones.

K. These and many other of different kinds of earth, have been comprehended under the denomination of *Schisti*; but to avoid ambiguity we will confine this name to stones of the argillaceous kind.

The

The bluish purple schistus, or common roof slate, *schistus tegularis*. It does not strike fire with steel, and may be slightly scraped with the nail.

It is very brittle, and of a lamellar texture.

Its specific gravity is 2876.

When in pieces of half an inch thick, it gives a clear sound if struck.

Its grain is moderately fine: and it never is transparent.

Effervesces slightly with acids when powdered, otherwise not.

When made red hot, loses more than two per cent of its weight.

It detonates slightly with nitre, and then assumes a brownish red colour.

But calcination does not render it magnetic.

In a stronger heat it is fusible *per se*, and forms a black scoria. It is difficultly dissolved by mineral alkali, in the dry way, but more easily by borax and microcosmic salt with little effervescence.

It melts with equal ease in chalk or clay vessels.

Dephlogisticated spirit of nitre, after standing on it two months in the cold, assumes a green colour.

It contains 26 parts of *Argill*: 46 of *flex*: 8 of *Magnesia*: 4 of *calcareous* earth: and 14 of *iron*.

Part of its iron seems to be in a phlogisticated state, from its union with a mineral oil that is contained in it:

And part in a dephlogisticated state, or in that of *red* calx: this is united to the argillaceous

part and to the siliceous also : and is very difficultly separated.

Its colour varies to the pale, to the slightly purple, and to the bluish.

The lamina of these last are thicker, and their texture is coarser.

They contain more of the siliceous earth, and less of the iron calces.

Other stones are also used for covering houses in various countries : but they are easily distinguished, as their lamina are much thicker, their surface more uneven, and their texture coarser. They chiefly belong to the sand stones, or to the calcareous kind.

The dark blue slate, *schistus scriptorius*, effervesces more briskly with acids ; it contains more *magnesia* and less *iron* than the preceding.

Its specific gravity is 2701.

SECT. 147. (Additional.)

The Pyritaceous Schistus.

It is of a grey colour, brown, blue, or black.

It is more or less decomposable by its exposure to air, according to the quantity of the pyritous ingredient and the state of the iron in the pyrites.

If this iron be in a semi-phlogisticated state, it is easily decomposed,

But

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But if the calx of iron be already much dephlogisticated, it will be decomposed but slowly, if at all.

The aluminous Schistus is of this species.
Kirwan.

SECT. 148. (Additional.)

The Bituminous Schistus,

Is generally black [x], of a lamellar texture, and of different degrees of hardness.

But never gives fire with steel.

It emits a strong smell, when heated.

And sometimes without being heated.

When scraped, it does not shew any white mark like the other schistus. *Kirwan.*

[x] I have a specimen of the bituminous schistus, which burns like coal, with a strong smell of mineral bitumen, but it is of a yellowish brown, or rather of a dark ash colour: this was found on the estate of Mr. Smith, near Thirsk, in Yorkshire. *The Editor.*

SECT. 149. (Additional.)

The Flag Stone.

It is of a grey, yellowish, or reddish white colour.

Does not give fire with steel,

Nor effervesces with acids.

Its specific gravity is from 2600 to 2780.

It is used in some places for covering of houses; but mostly for flooring.

It is sometimes compact and sometimes is like the argillaceous grit: and then its specific gravity is smaller, *Kirwan*.

SECT. 150. (Additional.)

The Argillaceous Grit,

This is called also *Sand Stone*, and *Free Stone*, because it may be cut easily in all directions.

Its texture is more or less porous, equable, and rough to the touch.

It exhales an earthy smell when fresh broken and breathed upon.

Does not give fire with steel,

Nor effervesces with acids.

That.

Sect. 152. ARGILLACEOUS EARTHS. 363

That from *Hollington*, near *Utoxeter*, is of a whitish or yellowish grey, and its specific gravity is 2288.

That from *Knipersley* in *Staffordshire*, is of a grey colour, and so infusible as to be used for fire-stones. Its specific gravity is 2568. *Kirwan*,

S E C T. 151. (Additional.)

Killas.

This stone is of a pale grey, or greenish colour; either lamellar or coarsely granular. It is found chiefly in Cornwall. The lamellar sort is softer and has less iron than the roof shistus: its specific gravity is from 2630 to 2666. Out of one hundred parts, 60 are siliceous earth, 25 argillaceous, 9 of the magnesian earth, and 6 of iron. The greenish Killas contains more iron, and gives a greenish colour to nitrous acid. *Kirwan*.

S E C T. 152. (Additional from the Philosophical Transactions for 1782.)

Toadstone.

Dr. Withering, who has given an analysis of this stone, describes it as being of a dark brownish grey colour of a granular texture, not giving

fire with steel, nor effervescing with acids. It has cavities filled with crystalized spar, and is fusible *per se* in a strong heat. It is found in Derbyshire.

Mr. Whitehurst observes, that this is probably a volcanic product, and that the masses of spar it contains, appear to have filled the cavities subsequent to its original formation. For the toadstone, contiguous to a stratum of clay, is found to have baked it to a certain thickness. At 100 fathoms beneath the surface of the earth this stratum is quite solid, and is more and more porous at less depths. These pores in some specimens are quite empty, in others they are lined with regular crystallizations, and in others entirely filled.

The toadstone contains from 56 to 63,5 centesimal parts of siliceous earth, near 15 of the argillaceous: 7,5 of calcareous earth, and 16 of iron. See *Dr. Withering's account in the Phil. Transf. for 1782, p. 2.*

N. B. Mr. Kirwan remarks, that this stone differs but little from basalt, than which it is softer; contains a smaller portion of iron, and a larger of siliceous earth: so that it may be reckoned among the volcanic substances, at least among those which have undergone some change by volcanic fires. *The Editor.*

The compounds of this and other earths will be mentioned in the General Appendix of this Mineralogy, as well as the volcanic substances, according to the Author's idea in the first edition of this Mineralogy.

SECT.

S E C T. 153. (From a Note of the Author to his Section 91.)

Thoughts of the Author on the formation of Clays.

There is some probability, though not easily demonstrable, that common clay, and especially the blue, grey, and pale red, which are the soils of our plains and dales bordering upon lakes, has its origin from mud, and that the mud owes its existence to vegetables; consequently that these varieties of clay are nothing else but a mould, or *humus ater*, somewhat altered by means of water, after a length of time [a].

The

[a] These conjectures of the Noble Author abundantly shew his great sagacity in the investigation of phenomena that have any relation to mineralogical substances. But now that the *Argillaceous* is acknowledged to be a simple primitive earth, which cannot be decomposed into any other principles, nor formed by the combination of any other simple substances we know, we ought to rest satisfied at present, without endeavouring to account for its formation.

Professor Bergman has likewise hinted that *Argilla* might perhaps be a calcareous earth combined with some acid not yet discovered: but, says he, sect. 83 of his excellent treatise, intitled *Meditationes de Systemate Fossilium Naturali*, which he favoured me with, some few months before his death—"Sed, donec tales compositiones experimentis fuerint nudatae, respectu

The following circumstances contribute greatly to confirm this opinion, viz. that a great quantity of sea-plants rot every year in the lakes, and are changed into mud; that very little, however, of this mud is seen upon the shores after the water is dried in summer time; and that the clay begins where the mud ceases. Concerning the turf or peat, it is to be observed that this is not always produced from vegetables growing upon the very same spot where it is cut, but from such vegetables as have been thrown together from other places: for in what other manner could hazle nuts occur in the turf moors, in places where no hazle trees grow, even at the distance of many miles; not to mention other instances of the same nature. Secondly, the turf or peat, is cut in humid and low marshes, which are not constantly covered with water, as on the banks of lakes overgrown with grass. If the origin of turf was any other than here mentioned, there ought to be turf found instead of mud, at the bottom of lakes where there is plenty of grass.

nostræ cognitionis, instar primitivarum considerari & possunt & debent; e sola namque possibilitate in Philosophia Naturali nihil stabilire convenit. Quotidiana satis edocet experientia, quæ maxime probabilia videntur, alio tempore revera falsa reperiri."—In English. *But compositions of this kind may and even ought to be considered as primitive substances with respect to our knowledge of them, till they shall be experimentally decomposed. For no sound knowledge in natural philosophy can be obtained from the consideration of mere possibilities, since daily experience shews that even the most probable suppositions have proved false, when the means of putting them to the test have afterwards been found out, Edit.*

The

The quantity of iron, and of the vitriolic acid contained in this clay, would perhaps not be found greater than to answer in proportion to the quantity of each of these substances, that enters into the composition of vegetables, whilst growing, if there were any possibility of making the comparison. In the mean while it may be some confirmation to this doctrine to mention that I have in dry summers observed on the sea-shore, that a perfect iron vitriol has been growing out of the mud, clays, and vegetables not yet rotted, that have been thrown up there together.

When this opinion is once proved to be true, we may venture to go farther, and endeavour by observations and experiments to prove likewise, that in the subversions or changes that the earth has more than once suffered in every part of it, and in which water has contributed the most to carry off the particles, and to change the strata, the clay has been gathered together, and lodged in beds together with other substances. Some of these strata have afterwards been indurated by themselves or with calcareous earth, by which means they became converted into the above slaty and limy clays[b]: and
when

[b] The argillaceous earth being a primitive one, and the subversions and changes of this terraqueous globe being evidently demonstrated to every one that attentively considers its interior structure, we may easily conceive how those various strata of this *argillaceous* earth might happen to be formed, like those of the *calcareous* and of other fossils in various parts
of

when they have been mixed with a great quantity of vegetables, and of the inflammable substance, they may in length of time have been changed into pit-coal: but when they have been mixed with less phlogiston, and a great quantity of the vitriolic acid, they constitute the alum ores, &c. Others of those strata, which are not yet hardened, prove moreover, by their being set or divided with some separating veins of sand, that they have been formed in the same manner as the settlings or sediments of stamping mills, and may perhaps, through edulcoration in water, or through age, have lost their fertility, since they never are so good to improve lands with, as those strata which are supposed to be of more recent formation.

of the globe, without having recourse to the change of any previous substance into this kind of earth, as hinted by the Author.

We may allow, nevertheless, without great hesitation, that in some particular circumstances, similar changes may have taken place; if we can rely on the observations of Messrs. Targioni, Ferber, and Mascagni in various parts of Tuscany and Naples, chiefly near the lagoons, or lakes, which in all probability are the craters of old and unrecorded volcanos, and found which sulphureous vapours, and ammoniacal exhalations, are still rushing out of the neighbouring places, that not only the *schisti* or *slatey* substances, but the *hornblendes* (*lapides cornei*) the *albarese marbles* and even the *quartzous stones* are found partly reduced into the argillaceous kind. See the *Treatise of Mr. Mascagni on the Lagoni del Senese & del Volterrano*, Art. 6. printed at Siena, 1779, 8vo. The Editor.

S E C T. 154. (92.)

Observations on Clays in general.

Those who have taken upon themselves to examine the mineral bodies according to the principles upon which this system is built, will readily, I hope, excuse those faults which may have been committed in classing the clays; because they must well know, not only how difficult it is to procure a number of different varieties of this order in their natural state, which have not been previously washed or prepared for use, as the sealed earths, &c. but also that it is no easy matter distinctly to describe some little circumstances that occur to the eye, both in their natural state and during the experiments. Besides, they cannot but remember, that the progressional degrees both of hardness, and of the quantity of mixed heterogeneous bodies, especially iron, produce a number of imperceptible differences between them, in regard to colour and effects, so that they cannot with due precaution be separated and divided into their true genera, species, and varieties before some more evident differences between them may, by repeated experiments, and perhaps by processes yet unknown be discovered.

The degree of fire is so much the more important in the examination of clays, as without
it

it, we can never avail ourselves of them in common life. For, as it is wrong to assert with some authors, that refractory clays never crack in the fire; their not imbibing water when burnt, is a character equally fallacious, unless the manner of working and the degree of fire are taken into the account. Hence comes that great difference in regard to appearances and qualities, between a tobacco pipe, which is very little baked, and a jarr from Waldenburg; between a common brick, and the other sort called a Water-clinker.

The use of clays in common life, is more extensive than I have here room to specify; for which reason I will only mention some particulars relating to it.

The porcelane clay is employed to make vessels which have the quality already mentioned (Sect. 131). I make no doubt but it enters into the composition for making the fine porcelane ware at some places; at least vessels are prepared from it of the same goodness in every respect; and there are likewise some varieties of this clay, which become quite white in the fire, a quality which is esteemed the most valuable in the fine china-ware.

The indurated porcelane clay cannot be easily heated without cracking, and therefore we can go to no great length in the hardening it by fire; though this circumstance is of less inconveniency, than when it has original cracks, or is mixed with heterogeneous substances.

The steatites (Sect. 57), is purer and more solid in China than any place in Europe. The natural faults of the European ones may, however, be altered by adding some fat substance to it, when it is to be burnt: by which means it becomes black or brown; and this method is said to be used at Bareith. The coarse porcelane-like earth, is used under the name of *French Clay*, at the glass-houses, steel-furnaces, and other works of the same nature, for the same reasons as it is the principal ingredient in the making of crucibles, retorts, &c.

The boles have almost lost their value as medicines, and are employed to make bricks, potters ware, and pig-iron.

The tripoli is an indispensable article for the polishing of metals, and some sorts of stones; it is likewise on certain occasions preferred for making moulds to cast metals in.

Clay is of the most indispensable advantage to agriculture. We must however except the white clay and the fermenting clay, both of Sect. 144, varieties whose utility has not been discovered. By virtue of its coherency, clay retains humidity, on which, perhaps, its chief power of promoting the growth of vegetables depends, its other effects being adventitious either from natural or artificial circumstances; unless the clay has formerly been a mould or *humus ater*, in which case it is reasonable to conclude that part of it will enter again into the formation of new vegetables. The clay used in the refining of sugar requires no other quality than

than that it may not dry too soon [c]. But that species which is to be employed in fulling, must, if we were to judge *à priori*, besides the fineness of its particles, be of a dry nature, or such as attracts oils; though this quality may not, perhaps, be found in all those clays which are now employed in that business [d.]

[c] Common clays are used in the refining of sugars, in order to hinder their too precipitate defecation. *Wern.*

Clays, as found in the strata of the earth, contain in the first place the *basis of alum*, or *clay*, properly so called; and secondly *siliceous* earth or *sand* more or less subtle; very often they also contain the *vitriolic* and sometimes the *marine* acid, both of which may be separated from them by fixed alkalis. Besides the above principles which are common to the most part of clays, many contain *micaceous* particles of a greater or less size: *calcareous* earth; *metallic* substances: *volatil alkalis*; and even an *inflammable matter*, although some controvert the last, saying that clay does not make any detonation when exposed to fire: but this argument has no weight, since there are undoubtedly many substances in which the inflammable principle is very copious; and nevertheless they do not detonate in fire.

These earths crack in the fire, only when they have imbibed some moisture, or on account of some heterogeneous mixture: but when perfectly dried, they sustain the fire without cracking, and acquire a considerable hardness, even so as to strike fire with steel. When mixed with a small portion of *sand* and of *calcareous* earth, they not only acquire a great hardness in the fire, but shew a vitreous appearance in their fractures.

The pure white clay being calcined in a strong heat acquires a phosphorescent property. *Fabroni.*

[c] See Note i and j to Sect. 133, pag. 236 and 237.

The examination of the component parts of earthy substances is a very essential object for a rational mineralogist: and deserves to be attended to with the utmost care and diligence. An idea of the method for making a proper analysis of these substances should undoubtedly be given in this place; that beginners on Mineralogy might exercise themselves in so important a part of knowledge. But as Mr. Kirwan has given already a copious account of his practical analysis of earthy substances at page 160 of his Mineralogy: and as no mineralogist ought to be without that excellent work, it would be needless to transcribe it in this place.

The EDITOR.

CLASS

C L A S S II.

S A L I N E S U B S T A N C E S.

S E C T. 155. (119.)

*General Properties of Salts.*NOTICE The Salts. *Salia*. Lat.

By this name those mineral bodies are called, which can be dissolved in water, and give a taste; and which have the power, at least when they are mixed with one another, to form new bodies of a solid and angular shape, when the water in which they are dissolved is diminished to a less quantity than is required to keep them in solution; which quality is called Crystallisation [e].

In

[e] The general character, or the definition of salts given by Bergman, has been inserted in Note g, page 10: but Dr. Withering has observed that the same definition does not apply perfectly well to some of the simple salts. Dr. Black, of Edinburgh, defines salts by saying that *saline substances are sapid, mixible with water, and not inflammable*: but the same Dr. Withering rightly remarks, that this definition is also exceptionable: since it has been found, that volatil alkali, in an aerial form, is in a certain degree inflammable. *The Editor.*

No

In regard to the known principal circumstances or qualities of the mineral salts, they are divided into

1. Acid Salts, or Mineral Acids, *Salia Acida.*
2. Alkaline Salts, or Mineral Alcalis, *Salia Alkalina.*

Till

No other salts ought to be considered and ranked in a mineral system, than those which are found natural in the earth; and for this reason a great number of Salts will be in vain looked for here, viz. all such as are either natural or prepared by art in the other two kingdoms of nature, and from substances belonging to them. *The Author.*

I must confess that the noble author's reason for excluding many substances out of his mineral system that are not formed in the earth, does not appear to me satisfactory. For if those substances ought to be excluded which are never found but in a state of combination or mixture, the earths and metals will present us with no small number of even primitive substances that demand rejection. And with regard to such matters as are said not to be formed in the earth at all, though they strongly resemble other mineral substances, such for example as the nitrous acid and fixed vegetable alkali, the first of which has been said to require the putrefactive fermentation to produce it, and the latter to be produced by calcination, we cannot be too cautious in rejecting them. For, without mentioning the great probability that future researches may find such in the bowels of the earth, it does not seem consistent with the laws of a rational mineralogy to place a greater dependance on the original existence than on the external characters of bodies, which last our illustrious author has reduced to their true value by classing them according to the chemical analysis of each substance. It is not in fact *what* a fossil might have been formerly; but *what it is*, that must determine its right to enter into a system of natural knowledge. The mineral kingdom is as it were the receptacle for all bodies that are not either in the vegetable or animal state. *The Editor.*

Till of late no more mineral acids were known than the vitriolic and marine; the boracic or sedative salt being reckoned as produced artificially: but later discoveries have proved that we may reckon at least eleven mineral acids, out of which only

There have, indeed, been many attempts made to reduce most of the mineral acids to the vitriolic, which by many is called the universal acid: but experiments seem not to agree with it; at least nobody has yet been able, by uniting a phlogiston with any other acid than the true vitriolic, to produce a substance in every particular resembling the true brimstone or sulphur. For this reason I cannot yet give my assent to Doctor Pietsch's opinion, who endeavours to prove, that the acid of nitre is derived from the vitriolic acid, that is, before his theory is confirmed in the large way, and the analysis has been more plainly laid open: but I think the question remains still undecided, whether the nitrous, vegetable, and urinous acids are primitive substances? or if they owe their origin to one and the same principle? and, if this last be the case, of what nature this principle is? But howsoever this may prove, the consideration of these acids seems more properly to belong to another science. The same may be said of the doctrine which holds, that the nitre is produced from the principles of the sea-salt by a certain peculiar modification,

The above-mentioned mineral acids, which are by art extracted from the vitriols and the sea-salt, are indeed never found pure in nature, because as soon as they, on any occasion, are, either by a natural or artificial heat, separated from any substance, they instantly attack and unite with another. Nevertheless, as they may, and perhaps sometimes really do, exist in form of vapours, which escape our sight; and that the theory of the salts, and the saline ores, is founded upon qualities already discovered in these acids: I have thought it necessary to describe them such as they are, when mixed with pure water alone; and this the rather, since the water is their most common vehicle in the exercise of their effects in the mineral kingdom.

only two or three have been found in an uncombined state. Those hitherto known are the following, viz. the vitriolic, the nitrous, the marine, the sparry, the arsenical, the molybdenic, the tungstenic, the phosphoric, the boracic, the succinous, and the aerial: of which will be treated separately in the following sections. The Editor, chiefly from Bergman.

It has been observed before (Note k to Sect. 2.) that the qualities of arsenic in form of a calx, may agree with the definition of salts, and at the same time be reckoned among the semi-metals; which cannot be any otherwise explained, than that the arsenic, considered in a certain respect and form, is a salt; and when considered in other circumstances, a metal. This is the case with several other bodies of the mineral kingdom. *The Author.*

I learn by a letter from Chevalier Landriani, Professor of Natural Philosophy at Milan, dated the 2d of June, 1782, that Count de Saluces of Turin has converted vitriolic acid into nitrous and muriatic. There is also an experiment of J. G. Wallerius, quoted by Dr. Lewis on Nieuman, II. 265, where salt of tartar being mixed with some dulcified spirit of vitriol (or perhaps unrectified ether) produced, after standing corked for four months, a prismatic salt in some respects resembling nitre, particularly in that of detonating. The greatest part of the spirit of vitriol had made its escape.

The same Professor Wallerius affirms (page 13 of his Mineralogy, edit. 1778) that, according to the common opinion of chemists, the three mineral acids, viz. the vitriolic, the nitrous, and the muriatic, are identic, the two last originating from the first. But Chevalier Landriani, in one of his Opuscula, printed at Milan, where he treats professedly of this question, asserts that all acids derive their origin from the aerial acid or fixed air, as this aeriform substance is generally produced from almost all other acids, when treated by the proper chemical processes, which he describes in the treatise. See Note u to Sect 158, concerning the production of Nitrous acid, by Count de Saluces already mentioned. *The Editor.*

ORDER THE FIRST.

S E C T. 156. (120.)

Acid Salts. *Salia Acida.*

The characters of these salts are, that they,

1. Have a sour taste [*f*].
2. Are corrosive; that is to say, have a power of dissolving a great number of bodies.
3. They have a strong attraction to the alkaline salts and earths, whence they always unite with them with an effervescence, and sometimes with a strong heat; by this mixture bodies are produced, which are employed in common life under the names of *vitriols, neutral salts, gypsum, &c.*

[*f*] Sapidity or taste is so inherent a quality in salts, that we need not hesitate in affirming that this sensation is always caused by the action of saline matters on our organs. This sensation is infinitely varied from the most agreeable excitation of the perception to the most destructive and painful degree of causticity. Among acids the concentrated vitriolic and the mild tartness of vegetables form the two extremes; and the action of salts varies in every state of combination, so that in some its efficacy is so small as to be scarcely perceptible. *The Editor from Mongez.*

4. They

4. They change most of the expressed blue juices of vegetables into red[g].

5. They

[g] As the tincture of *b liotropium* is the nicest test of the presence of an uncombined acid, it may not be amiss to mention that it may be had from dyers under the name of *Litmus*. It is very cheap, and generally requires to be greatly diluted with distilled water before it can be used. *Withering*.

The infusion of *litmus* is sensible to the presence of *one grain* of common oil of vitriol, though mixed with 100,000 grains of water: but as this infusion does not change colour on being mixed with alkaline liquors, some vinegar must be mixed with it, so as just to turn the infusion *red*, which will then be restored to its *blue* colour by being mixed with any alkaline liquor.

This blue infusion turns red also, when mixed with water impregnated with *fixed air* (or *aerial acid*). But Mr. James Watt observed that a mixture of *phlogisticated nitrous acid*, with an *alkali*, will appear to be *acid* by the test of *litmus*, when other tests, such as the infusion of the petals of *scarlet rose*, *blue iris*, *violets*, &c. will shew the same to be alkaline: and I recollect that Mr. Ed. Hufsey Delaval, F. R. S. shewed to me some years ago that whenever phlogiston was contained in the liquors to be tried, we could not depend at all on this test.

As the above flowers mentioned by Mr. Watt, cannot be had but in a particular time of the year, he had recourse to another substitute, which is equally as good and nice a test for the same purpose as they are.

This substitute is the extract of the *red Cabbage* (*Brassica rubra*). A blue liquid is obtained by cutting off the stems, and mincing the thin parts of the leaves very small: afterwards digesting them in water, about the heat of 120 degrees of Fahrenheit's thermometer, for a few hours, and the clear blue liquor will be the most nice test, both for acid or alkaline substances, as it turns *red* with the first, and *green* with these last.

But as this liquid turns acid and putrid by long keeping, the above infusion of minced leaves of *red Cabbage* may be made in water acidulated with vitriolic acid not stronger than com-

5. They separate the alcali from the fat, when they have been united in soap; which effect is called to *curdle*, or coagulate.

6. They

mon vinegar, which may be neutralized when wanted, by means of *chalk*, or of *fixed* or *volatil alkali*, till it turns blue, taking care not to add too much of it, so as to become yellow, as it then cannot be restored back to blue. N. B. This infusion may be prevented from moulding in summer, by adding to it by a little at a time some spirit of wine. See Mr. Watt's paper, read to the Royal Society in May 27 last, printed in the 2d part of *Phil. Transact.* for the present year, 1784.

Acids not only turn these *blue* vegetable juices to a red, but they recover their blue colour after they have been made *green* by the mixture of an *alkaline liquor*. In general, almost all *red* vegetable juices are turned *purple*, then *blue*, and afterwards *green* by the mixture of an *alkaline liquor*, from whence they may be brought up successively in a retrograde order to the *red* colour, by the addition of an acid: and this may be repeatedly done with the very same vegetable extract many times, as I have repeatedly tried after the method of Mr. Delaval, F. R. S. above mentioned. This able philosopher points out the cause of these phenomena in his very elaborate and ingenious work, intituled, *An Inquiry into the Cause of the change of Colours*, &c. printed in 1774, and published in 1777, of which two different translations have been made in Italy, beside the French and other translations. The author explains these phenomena on the principles of Sir Isaac Newton, viz. that the ascending succession of colours, from the *green* to the *blue*, and so on to the *red* and *yellow*, as they appear in the rainbow, depend on the gradual diminution in size of the colouring particles: in consequence of which a small addition of *diluting* acid at a time, produces those successive changes according to the above order. On the contrary, by a gradual addition of a *condensing* (or saturating) alkali, the same change must take place, as it really does, but in an inverse order, from the *red* to the *purple*, then to the *blue*, and the *green*: but if *acid* enough is added so as to turn the

6. They are volatile and subtile, so as never to be observable by the naked eye, unless they are mixed with heterogeneous bodies; and therefore the figure of the pure mineral acids cannot be defined but by guesses [b].

the juices *yellow*, then they cannot be brought back again by the alkali to the *purple* or any other colour.

Thus far *theory* is supported by facts, and pethaps when our knowledge can be carried further, we may determine how the *acid* and the *alkali* produce the contrary effects of *attenuating* and *increasing* the bulk of the very same colouring particles of these vegetable juices, only to a certain degree, beyond which they are no more able to effect it.

We are also indebted to the same very able philosopher, Mr. Delaval, for the discovery, that colours are generally produced by *transmitted* or *refracted* rays, even from solid bodies, and not by the simply reflected light, as was commonly judged. This is the subject of a very elaborate Dissertation which the same gentleman sent to the literary and philosophical Society of Manchester: and will be inserted in the first volume of its Transactions to be published about the beginning of the next year 1785. *The Editor.*

[b] The author's words apply only to that case in which common acids assume an *aerial form*; but the contrary must happen, when they are in a concrete form, as will be mentioned at the end of Note *k* and Note *u* to the two following Sections: besides that some of the new acids (lately discovered) always appear in a concrete form, as will be observed in their respective Sections.

To this I may add, that on opening a few days ago a small phial I had almost forgotten in the corner of a shelf during these five or six years last, more than half filled with concentrated vitriolic acid, well covered with a ground glass stopple, I found that some small pieces of the concrete acid were sticking to the bottom of the stopple and to the upper part of the inside of the phial. These concretions were of various sizes and shapes: without any appearance of a regular crystallization. *Editor.*

S E C T. 157. (108.)

A. The vitriolic acid, *Acidum vitrioli, aluminis vel sulphuris.*

I. The pure vitriolic acid, *Acidum vitrioli purum,*

Is, in abstract, considered as possible to occur in nature [i]: its qualities, when mixed with water, in which it is caught by distillation, are as follows.

1. When mixed with the least possible quantity of water, it is of an unctuous appearance, and is for that reason improperly called *oil of vitriol* [j].

[i] Dr. Baltassari says that he found some dry concentrated acid, adhering to selenite in a grotto in *Monte Zaccbelino* near *Sienna*: but this has been fully disproved by the subsequent observations of Mr. Murray. *Kirwan.*

And Mr. de Dolomieu has affirmed that he found also the pure concrete acid of vitriol in a grotto near *Mount Etna*, as Mr. Mongez relates. This requires to be confirmed by further observations. See however *Note h to Sect. 156. Edit.*

Dr. Vandelli says that it is sometimes mixed with the streams from the hills in the neighbourhood of *Sienna* and *Viterbo* in Italy, raised no doubt by subterraneous fires.

Phlogificated or volatile vitriolic acid is frequently thrown out by the craters of volcanos: its smell is suffocating and penetrating: its union with phlogiston, and the matter of heat gives it an aerial form, but does not prevent its union with water. *Berg. Sciag. § 27.*

[j] The unctuous feel of the vitriolic acid seems to be produced by its action on the oily matter of the skin, with which it produces a saponaceous compound. *Editor.*

2. It

2. It has in that state a considerable specific gravity, viz. in comparison to water, as 1700 to 1000 [k].
3. It dissolves silver, tin, the regulus of antimony, and quicksilver [l], but,
4. When

[k] Vitriolic acid, when most concentrated by artificial means, has a specific gravity of 2125, according to Bergman: in this case it has 1698,1 parts of water mixed with 426,9 of pure vitriolic acid: whose specific gravity, if deprived of all the water, is equal to 4226: in other words, 1000 parts of this acid mentioned by Bergman, which is perhaps the most concentrated ever made, contains still 1698,1 parts of water mixed with 426,9 parts of the pure vitriolic acid according to the *Formula of Cotes* quoted by Kirwan in the *Phil. Trans.* 1782. *Editor*. This acid, when well concentrated, has neither colour nor smell. Mr. Helot, by the distillation of green vitriol in an extreme heat, obtained a concentrated vitriolic acid in a concrete and crystalline form. Meyer speaks of similar crystals, obtained by Nordhaus which were fuming. When this acid is well concentrated, it will freeze at a degree of cold between the 5th and 3d of Fahrenheit, as the Duc d'Ayen shewed in 1779. But M. de Morveau has frozen the vitriolic acid, with a less degree of cold. *Mengess. See also Note h to Sect.* 256.

[l] It dissolves cobalt, but only partially bismuth, antimony, or arsenic. As to quicksilver it is only corroded by this acid.

Gold itself is not exempted from the action of this acid, which dissolves it after precipitation from the *aqua regia*. It is even soluble in its metallic state by particular management. Both these solutions are crystallizable. *Fabroni*.

But, according to Mr. Kirwan's masterly experiments and deductions inserted in the *Philosophical Transactions* 1782, one hundred grains of meer vitriolic acid dissolve, and require to be saturated with, the following quantities of these metals, viz.

Mercury.

4. When mixed with more water, it dissolves zinc, iron, and copper.
5. It dissolves likewise the calcareous earth, and precipitates with it in form of a gypsum, of which a part shoots into gypseus Drusen, *Selenites et crystalli gypsei* of Sect. 18 and 19 [m].
6. It unites with a pure argillaceous earth, and dissolving it without any fermentation, makes alum [n].
7. It has a stronger attraction to the inflammable substance, than to the alkaline salt, and forms with it a body,

Mercury. Lead. Silver. Cobalt. Wismuth. Nickel.
 432 gr. 412 gr. 390 gr. 360 gr. 250 to 310 gr. 320 gr.
 Zink. Iron. Copper. Reg. of Arsen. Reg. of Ant. Tin.
 318 gr. 270 gr. 360 gr. 260 gr. 200 gr. 138 gr.
See the end of a similar Note to Sect. 159.

[m] With *ponderous earth*, it forms the *marmor metallicum*, or baro-selenite of Sect. 50.

According to Mr. Kirwan, *one hundred grains of pure vitriolic acid*, require for saturation the following quantities of the following substances, viz.

Fixed vege-	Mineral	Volatil	Calcareous	Magnesian	Argill.
table alk.	alkali	alkali	earth,	earth	earth
215 gr.	165 gr.	90 gr.	110 gr.	80 gr.	75 gr.

[n] It was said in the text, that vitriolic acid unites with the *earth of quartz*, when dissolved in the *liquor silicum*, with which and with *argillaceous earth*, it forms alum. But it is now fully demonstrated that the basis of alum consists only in the pure argillaceous earth. See Macquer's Dictionary at the article Alum. *The Editor.*

which properly may be called the *mineral sulphur*.

8. When it is perfectly united with phlogistic substances belonging to the vegetable kingdom, and the water has been perfectly separated, this mixture catches flame in the open air, and is consumed, as may be seen by the powder called *Pyrophorus* [o].
9. It attracts water strongly, and the aqueous vapours out of the air; and if a great quantity of water is added to it at once, a strong heat arises [p].
10. It unites readily and easily with the alkalis, whereby, according to their nature, different compounds are produced, which have obtained the names of *Tartarus vitriolatus*, *sal mirabile*, and *sal ammoniacum fixum*.

[o] The various theories of the pyrophori, none of which are yet incontrovertibly established, seem to render this character rather doubtful, or at least too remote to be offered as one of the vitriolic acid. *Editor*.

[p] The vitriolic acid not only expels the *aerial acid* or *fixed air* from calcareous or absorbent earth to unite with; but likewise the fluor or sparry acid from the substances of Sect. 22, and also the marine acid, in form of air. It disengages the inflammable air from different metals as iron, zinc, &c. of which, according to Messrs. Priestley, Kirwan, and other philosophers, this air is the true phlogiston. *Edit.*

S E C T. 158. (Additional.)

Nitrous acid. *Acidum Nitri*, Lat. *Acide Nitreux*, French.

Nitrous acid is by some excluded from the mineral kingdom, because they suppose it to be produced from putrefaction of organic bodies. But these bodies, when deprived of life, are again received amongst fossils, from whence their more fixed parts were originally derived [q].

1. In the most concentrated state that art can procure this acid, its specific gravity is 1.580. *Bergman* [r].
2. It is colourless when pure, but its strong attraction to phlogiston causes it usually to be of a yellow topaz colour. This superabundant phlogiston may however be dri-

[q] It is known by the important experiments of Doctor Thouvenel, that the nitrous acid is formed out of almost every substance, and therefore may be said to be common to all the three kingdoms of nature. *Mongez*.

[r] By the accurate experiments of Mr. Kirwan, it appears that the specific gravity of mere nitrous acid must be = 5530: but when it is found to be only 1560, in that case it contains 708,1 parts of mere acid, and 871,9 parts of water. See Note k to Sect. 157. *Editor*.

ven

ven off, and the acid rendered colourless [s].

3. United with an alkali it forms a salt which when in contact with a phlogistic substance in a red heat (either of itself or of the said substance) is rapidly decomposed, the acid flying off, or becoming destroyed in a peculiarly luminous flame, with a noise called *Detonation*, and the alkali, if fixed, remaining behind.
4. With different proportions of phlogiston, it forms *phlogisticated acid* and *nitrous acid* [t].
5. It has never, as far as we know, been met with disengaged, unless perhaps in water precipitated out of the atmosphere; but is found united to alkalis, or to earths. *Berg. Sciagr.* [u].

6. It

[s] The most highly coloured and fuming nitrous acid may readily be rendered colourless, by boiling it hastily in an open vessel. Part of the acid flies off, carrying the superabundant phlogiston along with it, in the form of *nitrous air*. Withering.

[t] Some modern chemists regard nitrous air as a principle *sui generis*, which requires only to be united to dephlogisticated air and water to produce the *nitrous acid*. This new etiology is the production of M. Lavoisier. *Mongez.*

An idea of the theory of M. Lavoisier may be had from the *Leçons de Chymie* of M. Fourcroy, pp. 53—64, vol. I. *Editor.*

[u] It appears by the experiments of Margraff (*Memoirs of the Berlin Acad.* for 1751) that rain and snow water contain uncombined nitrous acid. Burghart, in his treatise on *salt de seignete*, says that native nitrous acid is found in some mines, and

6. It acts very powerfully on all animal and vegetable

and particularly in those of Ukrania. Mr. Kirwan allows that it may, perhaps, be found in charnels and privies: and it was lately reported that a mine of nitre was found by Abbé Fortis at Malfette in the kingdom of Naples. *Editor.*

Mr. Le Comte de Saluces, President of the Royal Academy of Sciences at Turin, wrote me a letter dated the 21th of March 1783, including a printed one, directed to Messieurs Macquer and Cigna, in which he affirms that *the constituent parts of nitrous acid are an acidulous empyreumatic liquor, the volatil alkali, the calcareous earth, and a little vitrifiable earth: that, in consequence of these data, he had produced a real nitre, by combining these principles synthetically; that he had formed a true nitrous acid without the introduction of any matter that could be suspected of containing it: and that he has strictly demonstrated the conversion of the vitriolic into the nitrous acid: a little after, the noble author adds that the process for producing the nitrous acid consists in precipitating the earth of iron from a solution of green coperas by a volatile alkali. This precipitation is made with various phenomena, according to the intermedium made use of in decomposing the sal ammoniac: thus he has procured it by employing the volatil alkali obtained by means of oil of tartar, soap lees, and the liquor of flints. These liquors must at length become combined with the fixed alkali after a long repose, and after filtration be evaporated or distilled.*

The same noble author (in his letter directed to me) makes the following remarks.

1°. A recent solution of martial vitriol does not pass to the state of nitrosity. But, says he, an old solution appearing to me to differ from the other but in containing less martial particles, I boiled the recent solution, and having treated it like the other, it afforded no nitrous substance. Here, Sir, is a circumstance that has given me much trouble, namely to discover the decisive modification of this metamorphosis with regard to the acid. However, I flatter myself that I have succeeded in cutting this Gordian knot, &c.

vegetable substances; and even produces actual

2°. Solutions of the vitriols of copper or of zink, or the vitriolic acid in a fluid state, were not proper for effecting this metamorphosis.

3. The caustic or fluor volatile alkali has not succeeded, nor even the volatile salt obtained by *intermediums* under a fluid form.

The author concludes with the following propositions, which he promises to demonstrate at large in an elaborate work which he is about to publish, and which the public, no doubt, will anxiously expect. They are,

1. That effervescences do not depend on the prealable existence of a pneumatic gas.

2. That quick lime is not ineffectual with acids, nor even the volatile caustic spirit.

3. That the privation of gas in quick lime is not the cause of its causticity; and what is the cause of this property.

4. That nitrous gas is nothing else but the most volatile and concentrated part of the nitrous acid disguised by phlogiston.

5. That there is always a vacuum made in the vessels in which the operations are performed, and that the air expelled has often been taken for generated air.

6. That metallic calces do not contain air, and that the augmentation of their weight is owing to the part of an acid that combines with their phlogiston: and that mercury is augmented (in weight) in proportion to the loss of the nitrous acid.

7. That the air is the vehicle and specific menstruum of the volatile principles of bodies: that there is a part that forms a combination with them, another which is not in the state of aggregation: and lastly, another in which these new compounds are in a state of suspension.

8. That the pretended reduction of minium without an intermediate is not a true revival.

9. That red precipitate and minium decompose iron by their modification, each becoming reduced after its own manner.

10. That

actual flame when poured on oils [w].

7. It dissolves calcareous earths with which it forms deliquescent acrid bitter salts often phosphoric [x].

8. Is dissolves and corrodes all the metals in

10. That the inflammability of substances depends on the mode and not the quantity of inflammable matter they contain: and that there is a mephitism that depends on the excess of privation, or on the abundance of the aqueous principle.

11. That the coercive means (*moyens*) made use of, namely, water and quicksilver, are deceptive and very imperfect: and that the utensils of baked clay, or even iron, do not retain gases when they are penetrated by heat: that in short the methods in use are more elegant than good.

12. That charcoal in cooling takes up only the air it lost during ignition, which is but what could be expected. *The Editor.*

[w] It was formerly believed that the essential oils alone were capable of being inflamed by the nitrous acid: but my late good friend Mr. Rouelle junior shewed, in his public lectures of chemistry at Paris, that *les Huiles gras* (fat oils) would be equally inflamed by the same acid. *The Editor.*

Mr. Pronst has proved since, that in certain circumstances even charcoal may be inflamed by the sudden contact of nitrous acid. *Fabroni.*

[x] According to Mr. Kirwan's admirable tables of chemical affinities (in the *Phil. Transact.* for 1782), each hundred grains of pure nitrous acid requires for its full saturation the quantities of these substances; viz.

Vegetable	Mineral	Volatil	Calcar.	Magnesian	Argill.
fixed alk.	alkali	alkali	earth	earth	earth
415 gr.	165 gr.	87 gr.	96 gr.	75 gr.	65 gr.

pro-

proportion as it is concentrated and de-phlogisticated [y].

9. With silver, lead, or mercury, it forms crystalizable salts, but very deliquescent ones with copper or iron.
10. It forms nitrous air with the phlogiston of all the metals it can dissolve: but with tin and zink it not only forms nitrous air, but developes inflammable air.
11. It disengages the *aerial acid* or *fixed air* from marble, from spar, from zeolite, from chalk, and from magnesia. *Fabroni.*

[y] The affinity of the nitrous acid to the metals may be seen from the following numbers, which denote the quantity of each metal that may be dissolved in one hundred grains of pure nitrous acid, taken from Kirwan's tables.

Mercury	Silver	Lead	Cobalt	Zinc	Nickel	Wismuth
416 gr.	375 gr.	365 gr.	350 gr.	304 gr.	300 gr.	290 gr.
Iron	Copper	Reg. of Arsenic.	Reg. of Antim.	Tin		
255 gr.	255 gr.	220 gr.	194	120 gr.		

The calces of gold are slightly dissolved in nitrous acid; however in its metallic state it may be diffused through, but not dissolved, in the concentrated nitrous acid; one instance of which I have seen at Paris in the laboratory of the President de Saron, by a process of Mr. Tillet, both members of the Royal Academy of Sciences. The process was this: 22 gr. of gold were melted together with 54 gr. of silver, 6 gr. of platina, and 145 gr. of lead, and the whole cupelled as usual: the button or residuum being properly laminated, was put in strong nitrous acid: and the solution being left to stand 24 hours, a visible pellicule of gold in its metallic form and colour was seen on the surface of the solution. *The Editor.*

S E C T. 159. (128.)

C. Acid of common salt. *Sal muriaticum. Muria.* Lat. *Acide Marin*, or *Muriatique.* Fr.

This acid, considered in that state in which it can be obtained, viz. in a mixture with water [a], has the following qualities.

1. It does not alter the fluidity of water, nor considerably augment its specific gravity, as the vitriolic acid does [b].

2. It

[a] The same experiments that evinced to Margraff the existence of the nitrous acid in rain and snow water (see Note *u* to the preceding Section) exhibited likewise the presence of the marine acid. It is out of doubt that this acid sometimes exists in subterraneous places, for it very often happens, that on the opening of saline wells, its presence is announced both by its smell and the white vapours it emits. *Mongez.*

Doctor Withering says that he has some reason to believe, that the Nevil-Holt water does contain some of the marine acid in an uncombined state. See his Note to § 29 of *Bergman's Sciagraphia.* *The Editor.*

It has a very peculiar and volatile smell. Deprived of its superfluous water it assumes an aerial form, for phlogiston seems to be one of its constituent parts. *Berg. Sciagraphia.*

[b] The most concentrated marine acid, according to Bergman, has a specific gravity of 1150. In this state it contains 928.7 parts of water, and only 221.2 of mere acid, as appears by the Rule of Cotes, p. 80 of his *Hydrostat.* 8vo. 1775: but mere marine acid according to the principles laid down by Mr. Kirwan has a specific gravity of 3106. See his *Memoir in the Phil. Transact.* for 1782. *The Editor.*

This

2. It is somewhat less active than the vitriolic acid.
3. It strongly attracts the alkaline salts; but, however, is forced to quit them to the vitriolic acid (and to the nitrous) when added to the combination [c].
4. It dissolves the calcareous earth; and makes with it a substance called *Sal ammoniacum fixum*. (§ 4. p. 17. and § 21).

5. When

This acid develops inflammable air from antimony, copper, iron, zinc, and tin; but at the same time it seizes a small portion of phlogiston, and forms the muriatic air. It neither produces nor develops any fluid when applied to wismuth or nickel. *Fabroni* from *Priestley*.

It is evident from the experiments of Dr. Priestley, that muriatic acid is the true marine acid air united with a certain portion of water. It is easily obtained by heating the fuming marine acid in a retort whose mouth is plunged beneath an inverted glass filled with mercury. *Mongez*.

This acid is transparent without colour when dephlogistified: but it takes a citron or straw colour, smoking and emitting a strong odour resembling saffron, when it contains phlogiston. *Fabroni*.

[c] This happens in consequence of the superior affinity, or chemical attraction that the two other acids have with these, or other substances: chiefly with alkalies and earths, though in regard to some of the metals its affinity is still superior, as will appear by the following tables, if compared with the similar ones of the two preceding acids. They are all taken from the above quoted Memoir of Mr. Kirwan, in the *Phil. Transact.* for 1782, viz. one hundred grains of muriatic acid requires the quantity of grains expressed under each substance, as follows:

5. When exposed to the fire, combined with a phlogiston, it exhibits a yellowish green flame [*d*].

Veget. fix. alkali 215 gr.	Mineral alkali 158 gr.	Volatil alkali 79 gr.	Calcar. earth 89 gr.	Magnes. earth 71 gr.	Silic. earth 55 gr.
Mercury 438 gr.	Silver 420 gr.	Lead 400 gr.	Cobalt 370 gr.	Wismuth 250 to 320 gr.	Zinc 312 gr.
Nikel 275 to 310 gr.	Reg. of Arf. 290 gr.	Iron 265 gr.	Copper 264 gr.	Reg. of Ant. 198 gr.	Tin 130 gr.

N. B. The above numbers express the relative affinities or power of attraction between the marine acid and the above substances, and the same must be understood of the numbers assigned to express the similar powers of the two preceding acids (the nitrous and vitriolic) to the above substances. But the common *tables of affinities* only express, by their order, what metallic substances precipitate others from different acids; and, as Mr. Kirwan observes, they ought to be only called *tables of precipitation*, which is a very different thing; since all precipitations certainly are the result of a *double affinity* and *decomposition*, the *precipitating* metal yielding its *phlogiston* to the *precipitated* metal, while this last yields its *acid* to the *precipitant*. See the above Memoirs of Mr. Kirwan, in the *Phil. Transact.* for 1782. *Editor*.

N. B. 2d. It must be observed on the above tables of affinities already given of the mutual attraction between the three mineral acids of this and the two last Sections, that whenever two numbers are assigned under the same substance, the smaller signifies the attraction of it with the respective acid, whilst in its metallic state: and the greater number shews its attraction after it has been partially dephlogisticated by its previous solution in the nitrous acid: for it is a general rule of Nature that, in all solutions, a part of the phlogiston of the metal must depart before the solvent be able to produce its whole effect upon it. *The Editor* from Kirwan.

[*d*] This acid combines itself more difficultly with phlogiston than the other two acids. It attacks and dissolves the white

6. When highly concentrated and pure, as when it is distilled from common salt mixed with pipe clay, it dissolves tin and lead: but when less pure, it dissolves copper, iron, zink, and the regulus of antimony: the copper is however more easily dissolved, when it is in form of a calx, as the calces of quicksilver and cobalt likewise are. *See Note c.*
7. It unites with silver dissolved in aqua fortis, and with lead dissolved in aqua regia, falling with them to the bottom, in form of a white spongy mass. This precipitate, exposed to the fire, still retains the acid, and melts with it into a glassy substance, which is not soluble in water.
8. It is greedy of moisture, and attracts it from the air; thus it promotes the decay-
ing of those dry substances with which it has been united.
9. Mixed with the spirit of nitre, it forms the menstruum called *aqua-regia*, which dissolves gold [e].

This

white metals the most easily. It dissolves all the metallic calces and volatilizes gold, silver, tin, wismuth, mercury and regulus of antimony. This shews that it adheres more strongly to the metals, though it attacks them more difficultly than the other acids. *Mongez.*

[e] Mr. Pott affirms positively, on the authority of Stahl, that the properties of the nitrous may be given to the marine acid by combining it with iron. But Mr. Macquer informs us that all the attempts of Mess. de Machy and Duc d'Ayen, who

This acid seems also, on certain occasions, to have got loose from those substances, with which it has been originally united in the earth: the *sal ammoniacum naturele* at Solfatara in Italy, and the *born silver ore* appear to be proofs of this, as they seem to be the products of time.

undertook this labour with the greatest attention, have proved fruitless. The Comte de Saluces, perpetual President of the Academy of Sciences at Turin, says expressly in the letter he has honoured me with, that he has converted the vitriolic into nitrous and afterwards into the marine acid.

It was likewise by the means of iron that this metamorphosis took place. *See Note u to the preceding Section.* But while the Stahls, the Potts, and the Saluces do not give us their processes so as to enable us to comprehend and repeat them, they must expect to be regarded as visionary enthusiasts, by the bulk of mankind. *Editor.*

S E C T. 160. (Additional.)

The *Fluor acid*, or *sparry fluor acid*. *Acidum fluoris mineralis. Lat.*

This acid is obtained by art, as it has never been found disengaged, but united to calcareous earth forming a sparry fluor, called *Derbyshire fluor*, *Cornish fluor*, *Blue John*, or *Amethyst root*, when of a purple colour. See Sect. 22, and following, concerning the substances arising from the combination of this acid with calcareous earth [a].

1. This acid is found in great quantity in all the fluor or phosphoric spars. It is disengaged from its calcareous base by distilla-

[a] This acid has not been long known. It was discovered by Mr. Scheele, the celebrated Swedish chemist. Doctor John Reinhold Forster published an English translation of Mr. Scheele's memoir, which had been inserted in the Memoirs of the Swedish Academy for the year 1771. Many chemists opposed this discovery, pretending that it was only a modification of the marine; and others, under the name of Boulanger, affirmed, that it was nothing else but the marine acid combined with an earthy matter. But at length the famous Bergman demonstrated that it was a true acid *sui generis*, and the results of its combinations shew the thing evidently. For clay, ponderous earth, magnesia, quick lime, and alkalies, furnish in combination with this acid, mineral salts very different from those produced with other acids.

tion with a stronger acid, either the marine or nitrous, but more easily with the vitriolic.

2. It is very volatile.
3. Its specific gravity never exceeds 1500.
4. Its vapours when hot corrode glass: and meeting with moisture deposit the corroded siliceous earth of the retort or vessel in which it is distilled [b.]
5. This acid can scarcely be obtained pure, as it always contains a small quantity of filix, from which, however, it may be precipitated by the addition of an alkali.
6. It is most pure when in the form of air. It is then heavier than atmospheric air, and kills animals immersed in it,

[b] This acid in distillation is drawn out in form of air. If it be then received into a vessel filled with mercury, upon which water is swimming, every bubble of air that rises, forms a vesicle by means of a solid crust that environs it, and by the accumulation of these vesicles is formed a kind of jelly, which proves to be the siliceous earth which the acid had volatilized and carried with it, after corroding the retort or phial of flint glass in which the operation was made. This singular phenomenon was discovered by the famous Dr. Priestley, whose name will descend to posterity in the company of the greatest philosophers. In this operation, which I have often repeated with singular satisfaction, the spar must be pulverized and put into the phial with vitriolic acid: and distilled as before mentioned. But it is necessary to attend to the consequences that might arise from the corrosion of the phial, as its contents might be thrown about and produce disagreeable and noxious effects by their corrosive quality. *The Editor.*

7. This

7. This air has a great tendency to combine with water, and produces heat during the time of combining.
8. It is colourless.
9. Its smell resembles that of the marine acid.
10. It mixes equally well with water or ardent spirit, the last not being sensibly altered by the mixture.
11. Its affinity is stronger to calcareous earth than any other substance: for that earth disengages it from any other substance it may be united with.
12. But being added to lime water, no precipitation takes place till it is fully saturated, when a regenerated spar is precipitated.
13. With pure siliceous earth, a solution is made of a sweet taste: which by standing becomes gelatinous [c].
14. Magnesian earth is dissolved by this acid: but by standing, part of the magnesia is precipitated, and the remainder takes the form of a gelatinous substance.
15. It dissolves iron, and its calx as well as zink, with great violence, and inflammable air is produced by these solutions: the solution of this last semi-metal is partly crystalizable.

[c] It was thought that siliceous earth was produced by the union of this acid with water: but this mistake has been rectified by Mr. Meyer of Stetin; see Note b to page 45.

16. Neither gold nor silver, quicksilver, lead, tin, wismuth, cobalt or regulus of antimony are at all dissolved by this acid : but copper is partly dissolved : the calces of the above metals, gold excepted, are also dissolved by it.

S E C T. 161. (Additional.)

The acid of Arsenic. Acidum Arsenici. Lat.

This acid is prepared by art. It is dry, and has a specific gravity of 3391. It is fixed and fusible in the fire until it has acquired so much phlogiston as is necessary to convert it into white arsenic. In a moist air it deliquesces. It is not found uncombined but connected to the calx of cobalt and also to phlogiston, forming either a brittle metal or its calx. *Bergman.*

The arsenical acid suspected by Stahl and by Kunkel, and almost demonstrated by Macquer, was at last established, developed, and exhibited by Scheele, and after him by the academicians of Dijon, and by Bertholet and Pelletier.

It is obtained pure by distilling, from the calx of arsenic, four times its weight of nitrous acid ; or otherwise a mixture of the calx of arsenic with nitrous ammoniac is to be distilled very slowly. A vitreous mass is left at the bottom of the retort, which attracts the humidity of the

the air and becomes fluid. This liquor is the arsenical acid in a fluid state, and the vitreous mass, before it deliquesces, is the arsenical acid in a solid state [a]. Its properties are as follow:

1. It turns the blue vegetable colours to red.
2. It combines easily with calcareous earth.

[a] The arsenical acid may be extracted either from white arsenic or its regulus by either of the three acids, the nitrous, the marine, or the vitriolic. It is even very possible to prepare it *per se*, as appears from the memoirs on the subject, inserted in the Journal de Milan, intituled *Raccolta d'Opusculi*. Whatever may be the manner of its separation, it may again be reduced into white arsenic or its regulus, by the addition of phlogiston.

To have this acid disengaged, nothing more is necessary than to separate it from the phlogiston that neutralizes it. The following method is the most easy and cheap that I have tried for this purpose.

Take two parts of white arsenic reduced to a gross powder, and put them in a glass retort. Upon this pour twelve parts of aqua fortis of a light straw colour and of a specific gravity to water of about 11 : 8 or 1375 : 1000. Join a receiver, and proceed to distillation. A sort of effervescence will take place, red vapours will arise copiously, and the nitrous acid will pass over at first yellow, and afterwards of a beautiful emerald green, and at last transparent and colourless, which shews the dissipation of the phlogiston. Continue the fire till the liquor in the retort becomes white and of an earthy consistence. This is nothing else but the dry arsenical acid in a sufficient degree of purity, and which should be made red hot for greater precaution.

Afterwards expose this mass to the air to fall in deliquescence: or, which is shorter, dissolve it in four times its weight of distilled water, and let it boil in the distillatory vessel till no more than half the water employed remains. It will then be the arsenical acid in a fluid form, and of a sufficient degree of concentration. *Fabroni.*

3. It

3. It is a powerful solvent of clay, particularly when heated, but it has less action on other earths.

It strongly effervesces with alkalis, and

4. Combined with the vegetable alkali, regenerates the neutral arsenical salt of the late Mr. Macquer.

5. When this acid is in a concrete state, if it be urged with the flame of a candle directed on charcoal with the blow pipe, it resumes its phlogiston with great rapidity and regenerates white arsenic. And,

6. Gives a smoke, the odor of which strongly resembles that of garlick.

7. It melts in the spoon, and does not fume, except in proportion as it receives phlogiston either from the flame or the metal it rests on, which is found corroded by the action of this acid. *Mongez.*

8. This is the only mineral acid that, being in a liquid form, makes no effervescence with any of the metals, except zink.

9. It precipitates the calcareous earth from lime water, forming with it a white salt almost insoluble in water, but which is soon taken up by an excess of this acid.

10. Quick lime takes this acid from alkalis, which shews its stronger affinity. *Fabroni.*

11. It dissolves metallic calces; and Bergman (*de Attraët. Elec.*) remarks that,

12. In

12. In dissolving iron it produces no inflammable air, because the phlogiston is immediately absorbed by the acid, and produces white arsenic. *The Editor.*

S E C T. 162. (Additional.)

The acid of Molybdena. *Acidum Molybdæne.* Lat.

This is very probably of metallic origin, though it does not yet appear to which metal it belongs. Seeing that arsenic, a brittle metal, by dephlogistication only is changed into an acid different from all other acids, it is not improbable that other metals may have an acid basis, although their phlogiston adhering more strongly has not yet been completely separated [a].

That this acid has a metallic nature, and has not yet been perfectly freed from phlogiston, is probable from the following considerations of its properties in consequence of the chemical analysis of molybdena made by the cele-

[a] Mr. Hielm, by the persuasion of the late Professor Bergman, attempted the reduction of the acid of molybdena into a metallic form, and at last obtained a regulus seemingly different from any other metal: although its further examination has not yet been sufficiently pursued. *Bergman's Scia-graph.* § 32.

brated Mr. Scheele and the late Professor Bergman [b].

1. Its taste is acid, and at the same time metallic.

2. Microcosmic salt and borax are coloured by it: and these salts are hardly coloured by any thing but metallic calces.

3. It is decomposed, by means of the phlogisticated fixed alkali, which always indicates the presence of a metal.

4. It is in a concrete form and does not deliquesce analogous to white arsenic.

5. Its specific gravity is 3460.

6. Its solution in distilled water reddens the blue tincture of turnsole; curdles soap-water,

[b] It is but a few years ago that Mr. Scheele discovered this acid, in the course of some researches he was busied in upon Molybdena. The account of the process may be seen in the Journal de Physique for 1782, tom. 20, page 442. The following is the substance of one of them. On an ounce and a half of pulverised molybdena is poured six ounces of diluted nitrous acid, the whole is put into a glass retort, luted with its recipient, on a sand bed. The acid at first has no action, but when the ebullition commences, it rises in red elastic vapours with a strong frothing. The distillation being carried on to dryness, the residue is of a cinereous colour.

On this residue is to be poured a like quantity of diluted nitrous acid, which is to be distilled to dryness and affords the same phenomena as before. But the residue is of a lighter colour than before.

After the same operation has been repeated four or five times, the residue is in form of a powder as white as chalk. This is to be decolorated with warm water til it has no more acid, and when dry will weigh about six drams and a half, and is the true molybdenous acid. *Mongez.*

and

and precipitates the sulphur from a solution of its hepar.

7. It becomes bluish by being boiled on the filings of any of the imperfect metals.

8. A very small quantity of alkali being previously added, it afterwards dissolves a much greater quantity at the heat of boiling water: and by cooling affords small irregular crystals. The small portion of alkali previously added, is sufficient to prevent its volatilizing in open vessels.

9. It effervesces with calcareous earth, magnesia, or clay: and forms neutral salts very little soluble in water.

10. It precipitates silver, mercury, or lead, dissolved in the nitrous acid, and likewise lead dissolved in the muriatic acid.

11. It precipitates ponderous earth from the nitrous or marine acids. And these precipitates are not the regenerated ponderous spar.

12. It disengages the aerial acid from fixed and volatil alkalis, and gives neutral acids that precipitate all metallic solutions, namely gold, corrosive sublimate, zink, and manganese of a white colour: iron and the muriatic solution of tin, of a brown colour: cobalt of a rose colour: copper of a blue, &c.

13. On the charcoal, if urged by the blow-pipe, this acid is absorbed. In the spoon it takes a white earthy appearance in the exterior flame: which becomes a fine blue white, when acted on by the interior apex of the flame. It gives a beautiful green colour to the microcosmic salt;

a cinereous color to the globule of borax, viewed by reflection, but which appears as an obscure violet if seen by transmitted light. It is the acid alone that colours the fluxes. *Mongez.*

See other properties of this acid in Note a of the following Section.

S E C T. 163. (Additional.)

The acid of Tungsten. Acidum Tungstenicum.
Lat. Acide Tungstenique. Franc.

Sir Tobern Bergman supposes, in his *Sciagraphia*, the tungstenic acid to be nearly allied to that of molybdena: but he has shewn elsewhere the real differences between these two acids [a]. This acid is found in the substance of this name, which was formerly called *lapis ponderosus*. *See Sect. 27 and the Notes thereon.*

Mr.

[a] In the *Journal de Physique* for February 1783, are inserted two Memoirs translated from the Acts of the Academy of Stockholm for 1781, composed by MM. Scheele and Bergman, in which the chemical analysis of the Tungsten is given in detail. The latter did not find the ponderous earth as the external appearances in it seemed to indicate, but the mere calcareous earth combined with an acid essentially different from other acids, though in some particulars resembling the acid of molybdena.

The most remarkable differences are,

The acid of molybdena is fusible in the fire, but the acid of tungsten is not.

2. The

The same professor strongly suspected that this acid is of a metallic nature (*Sciagraphia*. Sect. 33.). And this suspicion is now verified by the labours of Messrs. John and Faustus de Luyart, two Spanish gentlemen, who have applied themselves with the greatest success to mineralogical chemistry. They have demonstrated this truth by experiments made on Wolfram, a mineral hitherto ranged with simple manganese, but which is a distinct species on account of its combination with this metallic acid. A detail of the analysis made by these gentlemen may be seen in the *Journal de Physique* for October and November 1784. The result of these, together with those of Messrs. Scheele and Bergman are as follow:

The tungstenic acid is obtained in the form of a white powder [6].

This

2. The molybdenous acid has a stronger affinity with phlogiston, as may be seen from its union with sulphur, and the change it undergoes when treated with oil.

3. The calcareous molybdena is not turned yellow by the nitrous acid. (see Note *c* to page 47), and is easily soluble in it. The contrary obtains in the tungsten.

4. The ponderous earth united with the molybdenous acid is very soluble in water, but the same base united with the acid of tungsten is not.

5. The molybdenous acid has less affinity with the calcareous earth than the tungstenic. For in digesting calcareous molybdena with a solution of ammoniacal tungsten, that is to say, a combination of the tungsten acid with volatile alkali, the calcareous earth unites with the tungstenic acid, and regenerates the tungsten of Sect. 27.

[6] To separate the tungstenic acid from its base, the tungsten is to be reduced into powder, and mixed with four parts

This salt is not a simple acid, but rather a compound of the yellow calx of tungstene, combined with the alkali which dissolves it, and the precipitating acid; it is truly a triple salt, whose properties vary a little according to the different proportions, and the more or less perfect state of combination of its constituent parts, as may be easily evinced by the masterly experiments of the said Messrs. de Luyart, whose work is just now published in English, whilst this sheet was in the press. Perhaps, by multiplying experiments, a method may shortly be discovered of obtaining this acid pure, as has been done with the acid of arsenic. Such however as our knowledge stands at present, the properties of the tungstenic or wolfranic acid are the following:

1. It is soluble in 20 parts of boiling water, and then reddens the tincture of turnsole, tastes sweet at first, and afterwards bitter with a disagreeable roughness in the throat.

2. With the blow-pipe it melts by itself alone, and with other fluxes presents the same phenomena, as the calx of tungstene or wol-

of vegetable alkali. The whole is to be placed in a crucible and urged by fire. When the mixture is melted it must be poured out on a plate of iron, and afterwards dissolved in twelve parts of boiling water. Some time after, the liquor which floats above a white powder that falls to the bottom, must be decanted, and nitrous acid must be added to the liquor to saturation. The mixture will become thick and deposit a white powder, which being washed in cold water and dried, is the acid of tungsten. *Mongez.*

fram,

fram, of which mention will be made in its proper place among the semimetals.

3. When exposed to calcination, it sends forth the smell of nitrous acid, and turns yellow: but on cooling it remains white, insipid, and insoluble [c] This residuum melts by the blow-pipe, without addition.

4. The vitriolic, nitrous, or marine acids being poured on this salt, produce a yellow colour: and in the filtrated solution, a neutral salt is found, with the basis of fixed alkali, corresponding to the acid employed.

5. If, instead of pouring the acid on the salt, it be poured on its solution, no precipitate is formed, even on making the liquor boil, provided the acid be in small quantity: the solution in this case loses its sweet taste and acquires more bitterness. But,

[c] Professor Bergman has observed that this acid and that of molibdæna are much resembling the arsenic salt. And it is well known, says this eminent philosopher, that the regulus of arsenic is nothing but its acid saturated with phlogiston: and that its white calx is in an intermediate state between acid and metal, containing just such a quantity of phlogiston, that the acid is coagulated, but remains still soluble in water, and shews marks of acidity. And adds, that by this analogy if admitted, we may judge that all other metals should consist in similar cases, of so many different fundamental acids, which, with a certain quantity of phlogiston, are coagulated to a dry earthy nature, viz. their calces; and by a full saturation are brought to the state of compleat metals.

It is therefore consonant to this very rational theory, that this saline substance being partially deprived by fire of one of its component parts, it should reassume some of the properties of its metallic basis becoming yellow whilst hot, and insoluble when cold, &c. *The Editor.*

6. If a large quantity of acid be added, the yellow tungstenic calx is then precipitated.

7. The acetous acid, or distilled vinegar, dissolves this salt compleatly by ebullition: and this solution being left to cool, there is a white matter, adhesive like wax, deposited on the sides of the vessel: which being washed, and kneaded with the fingers, forms a mass adhesive like bird-lime, which has a fat and very sweet taste to the tongue. This, on being exposed to the air, acquires a dark-grey colour, loses its adhesive quality, and grows bitter. This matter dissolves in water, and gives it at first a sweet, and then a bitter taste: makes the blue paper of turnesol red, and has the other properties of the salt, except that it turns blue with vitriolic acid, and that it precipitates the vitriol of copper.

8. When a quantity of lime-water is poured upon the solution of this acid salt by distilled vinegar, or nitrous acid, white precipitates are formed; and all of them are a true regenerated tungsten.

9. This acid with borax, being urged with the blow-pipe, produces a blue glass: and

10. With microcosmic salt gives a sea-green glass.

11. The solution of this acid in water, being saturated with salt of tartar, produces a neutral salt in very small crystals.

12. With volatil alkali, it forms an ammoniacal salt, figured like the points of small pins, which in distillation give over the alkali in a
caustic

caustic state. This ammoniacal salt decomposes nitrated lime, producing a regenerated tungsten.

13. The solution of this acid, mixed with magnesia, produces a neutral salt of difficult solubility in water.

14. It produces no change on the solutions of alum, or lime; but it decomposes acetated ponderous earth, and precipitates it absolutely insoluble in water.

15. This acid precipitates of a white colour the vitriolic solutions of iron, zink and copper: as well as the nitrous solutions of silver, mercury, or lead, and also the solution of this last in the marine acid. But the muriatic solution of tin is precipitated of a blue colour. The muriated corrosive of mercury and the solutions of gold are not changed by this acid.

S E C T. 164. (Additional.)

The phosphoric acid. *Acidum phosphori.* Lat.
Acide phosphorique. French.

This acid has as yet been discovered in no other fossil substance than one species of lead ore. It has lately been procured in great abundance from bones [a]. Fossil bones and some vegetable substances likewise contain it.

i. It

[a] Mr. J. G. Gahn is the first who discovered the phosphoric acid in a calciform kind of lead ore, as professor Bergman observes in his treatise on the *Docimasia Humida.* Sect. 7. pag. 424, and in his *Sciagraphia,* Sect. 34.

Phosphorus was discovered in the year 1677, by an inhabitant of Hamburg, who was searching for the philosopher's stone. His name was Brandt. This discovery was much talked of, and Kunkel associated with Kraft to procure the secret: but the latter, thinking to have made a great fortune, purchased it for himself alone, under a promise not to communicate it to Kunkel. Kunkel, irritated at his duplicity, began to make experiments on urine, the only circumstance he had come to the knowledge of, respecting the production of phosphorus: and applied himself with so much activity and perseverance, that at length he discovered the process. It is therefore with justice that phosphorus is called by the name of Kunkel, to whom the public is indebted for the discovery, and not to Brandt or Kraft, who kept it a secret with a view to enrich themselves.

It is certain that the famous Boyle likewise discovered the method of making phosphorous, after having bought a piece of Kraft, in 1679, to shew it to the King and Queen of England,

1. It is fusible in the fire, and takes a concrete form.

2. When deprived of water, its specific gravity, according to Bergman, is 2687.

3. It

land, and that he communicated his process to Godfrey Hankwitz, who supplied all the philosophers in Europe with this substance. Boyle published his process in 1680, which may be seen in the Philosophical Transactions of that time. Macquer, from whom this recital is taken, speaks of a stranger who communicated this process to the academicians of Paris, but he does not mention his name, probably for very sufficient reasons. But till very lately, that Scheele's new method of procuring phosphorus from the calcined bones of animals, all Europe was supplied with this extraordinary chemical production from England.

To obtain the phosphoric acid, and thence phosphorus, the bones of animals are to be calcined, hardly to whiteness, and no more: then reduced to powder, and well sifted. In general this trouble may be spared by buying the powder that is sold to make coppels for essays, and is in fact the powder of burnt bones ready sifted. This is to be mixed with an equal weight of the vitriolic acid, being thrown in by little and little, on account of the vapours that arise. In the process I was a witness to in the laboratory of the President de Saron at Paris, no more than three pounds of calcined bones were mixed with two pounds of good concentrated vitriolic acid. In adding the powdered bones, care was taken to stand on the side on which the wind blew, in order to avoid the vapours. Four or five pounds of water were afterwards added. The whole was then left in repose for twelve or even twenty-four hours, care being taken to add water in proportion to the loss by evaporation: so that the whole was kept to the consistence of soup. It is preferable to leave the whole in digestion on a gentle sand-bath.

The following day, twelve, or even twenty-four pounds of water must be added, and the whole filtered or passed through a fine sieve. The residue must be edulcorated by fresh hot

3. It powerfully attracts moisture and assumes an oleaginous appearance like the vitriolic acid, but it recovers its concrete form by the action of fire.

4. While

water added till it passes tasteless, and precipitates nothing from lime water. Evaporate all the filtrated water to dryness, and removing the residue into a crucible, urge it by a violent heat. The matter will then be reduced to the form of glass, and is the ammoniacal phosphoric acid in a solid form. Pour out this glass on a marble or other smooth surface. It must be covered with a bell glass, because it attracts the humidity of the air if left for some days. This vitreous acid is nearly transparent. I have seen specimens of this acid prepared by the method of the Duc de Chaulnes, as clear and beautiful as the finest crystal.

To obtain phosphorus nothing more is necessary, than to reduce this acid to powder in a mortar, before it has attracted the moisture of the atmosphere, otherwise it must be previously dried by heat: mix it well with an equal weight of pulverized charcoal well dried. Put the whole in an earthen retort, and adapt a balloon receiver half filled with water. The receiver must have a small perforation to suffer the expansive vapours to escape; but if it be tubulated after the manner of Mr. Woulfe, the vapours will be absorbed by the water in which the tube is immersed.

As soon as the retort is red hot, the phosphorus will enter the balloon by drops; which ceasing, the whole apparatus must be suffered to cool. The phosphorus, which is in masses resembling wax or reddish tallow, must be cautiously pressed together, because a small grain adhering to the skin, or beneath the nails, may do considerable damage by catching fire in the air. Small glass tubes are then to be taken a little conical, and the lower ends being closed with cork, they are to be filled with the phosphorus, the operation being performed under water. The tubes being ranged perpendicularly on the bottom of the vessel, the water must be heated, though not to boiling, and the phosphorus will melt, the purer part falling
to

4. While in a fluid state it has an acid taste.
 5. It reddens the blue vegetable colours.
 6. It decomposes nitre and sea-salt by combining with their alkaline bases and expelling the acids.
 7. With alkalis it forms peculiar neutral salts.
 8. It dissolves aerated earths with effervescence.
 9. It acts on siliceous earth and on glass.
 10. It dissolves neither lead nor zink, unless it be very concentrated.
 11. The solution of zink in this acid exhales a foetid odor.
 12. Its fixity is very singular. For it may be melted and even ignited without subliming.
-

to the bottom, and the impurities rising to the top. When all is cold, the sticks of phosphorus are to be taken out of the tubes, and the impure parts cut off, still remembering to keep the phosphorus under water. Phosphorus may be rendered very pure by a second distillation with a very gentle heat.

As to the fluid phosphoric acid, it may be procured from phosphorus by placing pieces of this substance on the sides of a glass funnel whose spout is received in a glass bottle. The funnel must be covered, and a piece of glass tube placed in the aperture, to prevent the solid phosphorus from falling through. At the end of a certain time more or less long, according to circumstances, an ounce of phosphorus will have afforded three ounces of acid mixed with the water that should be previously put in the bottle.

This acid is obtained from all the solid part of animals, as well as from urine, flesh, &c. Margraff has also obtained it from cheese; and lastly, Mr. Gahn has obtained it from the mineral kingdom, as already mentioned. *The Editor*, from *Fabroni, Menges, Macquer, &c.*

After

After this operation it is solid and transparent like glass.

13. By distillation with zink in a high degree of heat, it produces phosphorus in a considerable quantity.

14. It attacks and dissolves iron and the calx of copper very readily. But it acts feebly on copper in its metallic state, only rendering its filings green.

15. By fusing it with tin, lead, iron, or zink, it produces phosphorus.

16. If by any means united to phlogiston, it forms the phosphorus called after Kunkel, its inventor.

17. And in this state it precipitates almost all the metals in the metallic form from their solvents [b].

[b] The Marquis de Bouillon was the first who reduced silver by phosphorus in the dry way. Mr. Sage, of the Academy of Sciences, gave him the idea of attempting it in the humid way, which succeeded perfectly well. A stick of phosphorus is placed in the diluted solution of any metal: and at the end of a certain time it becomes coated with the reduced metal: so that when the phosphorus is melted out by hot water, the metallic tube may be rendered solid and smooth by a gentle fire. Copper is the best adapted for the experiment, and next afterwards gold, silver, platina and mercury. I have seen these tubes of gold, silver, and copper in the laboratory of Mr. Sage, at the *Hotel de la Monnoie*, and also in the laboratory which the President de Saron has fitted up in his own house for his chemical amusements. *Editor.*

S E C T. 165. (Additional.)

The Boracic acid. Acidum Boracis. Sal Sedativum. *Lat.* Sel Boracique, Sel Sedatif. *Fr.*

The mineral alkali contained in borax is saturated with the acid here mentioned. Its origin had long been a subject of contention : but it has been naturally found, within these few years, in certain stagnant waters near Sienne in Tuscany, and also crystallized with other saline matters on the mud of those lakes, after the water had been evaporated in a dry season [a].

This

[a] It was in the waters of the Lagoon named Cerchisio, near Monte Rotondo, that Mr. Hoeffler discovered the Sedative Salt here spoken of, and concerning which several disputes had been made among chemists. It naturally exists ready formed, and it is probable that the borax we receive from the East Indies, is formed by art, by the addition of an alkaline matter to waters of this kind. *Fabroni.*

It was on making the analysis of the waters of the above Lagoon called *Cherchiaio*, that Mr. Hoefer of *Cologne sur le Rhin*, Director of the mineral waters to the Grand Duke of Tuscany, found the boracic acid, of which discovery he published an account in 1778. But Mr. Paul Mascagni, Professor of Anatomy found the same acid in a concrete form in several streams of the Lagoons, in the neighbourhood of Sienna and Volterra. Mr. Mascagni enumerates six places, viz. the lake of *Travale*, 20 miles to the west of Sienna : that of *Rotondo*, which lies 30 miles to the west of the same town : that of *del Sasso*, three miles further : at another called *Sarazzano*, six miles from *Monte Rotondo* : another called *Castel Nuovo*, seven miles from *Monte Rotondo*, and twenty-four from Sienna : and that of *Monte Cerboli*, at the distance of four milés from

This salt is produced in a concrete form, like thin laminæ or scales, shining and very light, from borax, either by sublimation or crystallization, or by precipitation [b]: in the last case this acid is heavier.

1. Its specific gravity is 1480.
2. It acts like an acid, though very feebly.
3. It melts in the fire and volatilizes with water; that is to say, it evaporates partially with water on the fire, but after desiccation this salt is fixt: and if urged by fire it runs into a

from *Castelnuovo*. In the neighbourhood of all these lakes are considerable springs of hot water rushing out of the earth, some clear and some muddy, either of a dark or a whitish colour: and in some a kind of a metallic crust or pellicle is seen over the surface of the water. Many cavities from which these waters rush out, seem to be true small volcanic craters: and continually emit from the earth vapours of a sulphurous and ammoniacal nature.

Not only the boracic acid, both in the fluid and in the concrete state, is found in these waters, but various other concretions are there observed, such as martial vitriol, ammoniacal, aluminous, concrete boracic salts, brimstone, &c. See *Mascagni's account of these Lagoons above quoted*. Editor.

[b] The easiest method of obtaining this acid is given by Mr. Mongez. It consists in making a solution of borax in boiling water, and adding afterwards some vitriolic acid. This acid seizes the base of the borax, which is the mineral alkali, and the boracic acid is precipitated in the form of small brilliant scales, very thin and light. It is called Sedative salt, from Homberg, its inventor, who imagined it possessed a calming and even a narcotic quality. But these properties are far from being well established, and that name seems to be bestowed without reason, whereas the name of *Boracic acid* very conveniently points out its origin. *The Editor*.

kind

kind of glass, which attracts humidity if exposed to the air.

4. It is soluble in water, but requires a great quantity (50 times its weight) to be dissolved, though much less if the water be hot; one pint of hot water dissolves no more than 183 grains of this salt.

5. It is also soluble in spirit of wine, and gives a green colour to its flame.

6 This acid has very little taste, and does not change the blue colours of vegetables, according to Macquer : but according to Kirwan it turns the infusion of litmus red.

7. It is almost a neutral salt, though it possesses some qualities of true acid salts.

8. This acid decomposes nitre and common salt, by attracting their alkaline basis, and expelling their acids.

9. It attacks mercury, lead, copper, and zink, and forms with them neutral salts of very difficult solution.

10 It likewise attacks the earth precipitated from the *liquor silicum*.

11. It unites with almost all the earths, as barytes, calx and magnesia, and forms particular salts with them.

S E C T. 166. (Additional.)

The Succinous or Amber Acid. Acidum Succini. Lat. Acide du Succin. French.

The succinous acid or acid of amber is the name given to a concrete salt obtained from the fossil of this denomination. It possesses the properties of a true acid, though they are very feeble. It is not in fact decided whether yellow amber (distinguished from *ambre-gris* or grey amber, by the appellation *yellow*), owes its origin to the vegetable or mineral kingdoms; but it is as usually classed among fossils [a].

1. This acid combines readily with the vegetable and volatile alkalis, and forms crystals which are very deliquescent.

2. But with the mineral alkali it forms crystals that do not deliquesce by exposure to the atmosphere [b].

3. With

[a] From amber by distillation are obtained an acid liquor, an oil, and a crystallized (I think better to say concrete) volatile acid, which may be somewhat purified by solution and crystallization. *Bergman de Attract. Elec.*

[b] There is no acid whose combinations have been less examined into than those of amber. Its great weakness is doubtless the cause. Barchusen and Boulduc, the elder, are the

3. With *calcareous* or *ponderous* earths, it forms crystals very difficult of solution.

4. With the *argillaceous* earth it likewise forms crystals. But its combination with magnesia has a gummy or gelatinous appearance.

5. This acid dissolves metals when they are well dephlogisticated, that is to say it dissolves the metallic calces; and forms with them salts that do not deliquesce.

6. It has a stronger affinity to the *calcareous*, *ponderous* and *muritic* earths, than to *alkalis*: so that the former attract this acid from solutions of the salts into whose composition these last enter.

7. But among the three just mentioned earths its attraction to the *ponderous* is the greatest; as this earth will disengage that acid from its combination with either of the others.

8. *Lime-water* precipitates nothing from the solution of *ponderous* earth with this acid: but it shews a sufficient indication of this kind when added to magnesian succinous salt in solution.

the two first who observed the volatile salt of amber which was formerly taken for an alkali, but it possesses all the properties of a true acid. *Mongez.*

S E C T. 167. (Additional.)

Aerial acid, or fixed air. Acidum aereum.
Lat [a].

This acid is found either in an aerial state, as in subterraneous caverns, wells, and coal as well as other mines, where it is called *Choak damp*,

[a] The discovery of the *aerial acid* dates from the year 1770, when Professor Bergman published it in Sweden, whilst Dr. Priestley was making in England his numerous and important discoveries on this and other aerial substances, which have opened a new field of the utmost extent leading to the most abstruse recesses of the operations of nature, entirely unknown to, or even unsuspected by the philosophers of all preceding ages. Many were the objections to the existence of any acid in this kind of air, which has been called *fixed air*, since Doctor Black of Edinburgh had discovered its existence in a fixed state in alkaline salts, chalk, and other calcareous substances. But my late ingenious and worthy friend, Mr. Bewly, of Great Massingham, fully demonstrated that this aerial substance is a peculiar and distinct acid fluid *sui generis*, although by its subtle and rarified form, when uncombined, it cannot be shewn as easily as other strong acids, by the common salts generally employed in similar inquiries.

The present method for obtaining this aerial acid disengaged from chalk or other substances with which it is combined, is so generally known after these few years among those who practise philosophical experiments that I forbear to describe it. I'll notice, however, that to get pure *aerial acid*, by the usual method, the pellucid calcareous spar of Section 10 is to be employed, coarsely powdered, and mixed with distilled.

damp, and exists tolerably pure in the famous *Grotta del cane* near Naples; or combined with mineral water [*b*], absorbent earths, or ores, &c. &c [*c*].

1. Its specific gravity, in its aerial form, is 0,0018 [*d*].

2. Fixed

filled water, to which pure vitriolic acid is to be dropped, little by little, to expel the aerial acid, taking care that no heat be generated in the operation. Any other strong acid will also expel the *aerial* one, but both the *nitrous* and the *marine acids* are apt to be volatilised partially, and their vapour will mingle with the *aerial acid*. Even the vitriolic acid will mix with the aerial, if it is strong enough to generate considerable heat: but in this case it may be separated, by causing the aerial acid to pass slowly through a proper quantity of water, that is to say, in small bubbles through it; because the water will absorb the *vitriolic* part more readily, than the *aerial acid*, which however will also be a little diminished in its quantity by combining with the water in this operation. *Editor, from Bergman.*

[*b*] When the aerial acid is absorbed by common pure water somewhat above an equal bulk of this last (which is chiefly obtained by the process mentioned in the last Note *a*) the specific gravity of this aerated water is as 1,0015 to 1,0000, the thermometer being about the 35th or 36th *degree* of Fahrenheit. *Berg.*

[*c*] Fixed air may be expelled with effervescence by a stronger acid (See Note *q.* to pag. 17); or by a strong heat, from bodies where it is contained: and finally it may be extricated by fermentation. *Edit. from Berg.*

[*d*] Aerial acid, or fixed air, being about one and a half times heavier than common air, is the heaviest of all the aeriform substances we know. Professor Bergman says, that when the barometer stands at a mean height, and the thermometer at 15 degrees of the Swedish scale (answering to 59 of Fahrenheit) the specific gravity of aerial acid is = 0,0018,

2. *Fixed air*, or *aerial acid*, excites a distinct sensation of acidity on the tongue.

3. It reddens the tincture of turnsole.

4. It attacks fixed alkalis violently, and renders them mild, less soluble, and crystallizable.

5. In its union with volatile alkali, this last becomes more fixed, less odorous or penetrant, and crystallizes.

6. When combined with pure calcareous earth to the point of saturation, it takes away its solubility in water together with its causticity: and crystallizes it. But when it is super-

relatively to distilled water, whilst that of common air is only $\approx 0,0012$. The following Table is given, as the real weight of one cubic inch of each kind of the principal different airs, we are now acquainted with: but it must have been calculated upon experiments made in different temperatures from those which gave to Professor Bergman the above proportion, there being some variety in the relative weights; otherwise the weight of a cubic inch of aerial acid should be 0,5775 in the table, instead of 0,570.

A cubic inch of	{	Inflammable air	—	{	weighs grains	0,395
		Phlogisticated air by ni-	—			0,377
		trous air	—			0,385
		Atmospheric air	—			0,399
		Nitrous air	—			0,420
		Dephlogisticated air	—			0,570
		Aerial acid, or <i>fixed air</i>				

abundant

abundant, it renders the lime again soluble [e].

7. The same effects are produced by the *aerial acid* on *ponderous earth*.

8. It produces a neutral crystallizable earthy salt, when united with *magnesian earth*.

9. With iron, zink, and manganese, it forms salts, which, when dissolved in water, redden the tincture of turnsole, like all other metallic salts.

10. When combined, almost every other acid dislodges it from the substance it is combined with: provided it be at liberty to assume its elastic aerial form; which shews it is a subtle, but very weak acid.

11. It exerts elective attractions, both simple and double, as other acids do.

12. It precipitates substances dissolved in pure alkalis.

13. Notwithstanding its extreme volatility, it is very difficult to disengage it totally from water by boiling [f].

14. It

[e] Let a small portion of lime water be dropped into water impregnated with aerial acid, slight clouds are immediately formed, by the saturation of the lime with the fixed air. These clouds however disappear upon gently shaking the vessel, because the lime is again dissolved by the superabundant aerial acid, with which the water is combined. *Editor, from Bergman de Acido Aereo.*

[f] Water so impregnated will easily part with great part of this acid, in proportion as it is heated. But it will require

14. It strongly attracts phlogistic substances [g].

15. Its bulk is doubly expanded by ether: but if this increased vapour be passed through water, it then returns to its former magnitude and qualities.

16. The aerial acid prevents fire from being kindled, so as to prevent the explosion of bombs and fire arms. It even instantaneously extinguishes red-hot and flaming bodies.

to boil for half an hour before it parts with the whole. This aerated water has an acidulous taste, but when near the freezing cold its taste is less sensible. If proper salts and other ingredients are mixed with these waters, the best and most wholesome artificial waters are produced at home, far exceeding the natural and more celebrated mineral springs of Pyrmont, Aix-la-Chapelle, &c. &c. see Bergman's treatise on the subject, from whence I chiefly collected what I have published in a pamphlet intituled *Description of a glass apparatus for making the best Mineral Waters*, &c. the second edition of which was printed in London, 1783, in 8vo.

[g] A bottle of fixed air being plunged in spirit of wine, with its mouth downwards under the spirit of wine, this last will be found to absorb in a temperature of about 50 d. gr. of Fahrenheit, the double of its own bulk of *fixed air*. Oil of olives absorbs above its own bulk of the same, in the same circumstances. From whence it appears, that covering the surface of any fluid with oil, does not prevent it from absorbing *aerial acid*. Oil of turpentine absorbs the double of its own bulk of the same *fixed air*.

N. B. This great affinity with phlogiston seems to be the foundation of that quality which *fixed air* possesses of retarding putrefaction in dead flesh. See Sir William Lee's experiments, in the 4th Vol. of Dr. Priestley's Works on this subject, pag. 461. The Editor.

17. It

17. It kills animals, if surrounded or immersed so as to breathe therein. Even water impregnated with fixed air is fatal to fishes.

18. *Aerial acid* or *fixed air* seems to be produced by the union of *phlogiston* and *dephlogistinated air*. See the Remarks of Mr. Kirwan, read to the Royal Society on the 5th of February, 1784, and printed in the Philosophical Transactions of that year.

THE SECOND ORDER.

S E C T. 168. (135.)

Alcaline Mineral Salts, *Alcalia Mineralia* [a].

These are known by their action on the above-mentioned acids, when they are joined together,

[a] Alkalies are known by their peculiar lixivial urinous taste, by their vehement attraction to acids, and by their changing the blue colours of vegetables to the green. In a pure state, as was before observed of acids, their attraction to other substances is so strong that they cannot long remain uncombined; and if other acids were wanting, the aerial acid, every where present in the atmosphere, would unite with them: therefore they are always found in a state of combination, unless prepared and preserved by art.

New acids are daily detected, but no additions have been made to the three species of alkaly long since known. *Berg.*

Alkalis in general appear to be substances of much greater simplicity than acids, because they are much more difficult to be decomposed. When they are placed on the tongue, they develop an urinous and burning taste. They powerfully attract the humidity of the air, and readily unite with water. At the moment of mixture, heat is produced; though on the contrary, they generate cold when added to ice. We have remarked in the acids a very great tendency to combination: the alkalis possess it also to nearly the same degree of energy. Whence the extreme difficulty of meeting them naturally pure. *Mongez.*

Alkali

together, whereby a fermentation arises, and a precipitation ensues of such bodies as either of them had before kept in dissolution, uniting

Alkalis are of two sorts, fixed or volatile: the fixed are either of vegetable or of mineral origin, and differ in some properties.

It must be observed that some vegetables afford also an alkali intirely similar to that of mineral origin; particularly marine plants, or those which grow near the sea.

Neither of the fixed alkalis is ever found in a caustic state; but all are combined with the aerial acid. They then effervesce with most other acids.

Alkalis turn infusions of the blue flowers of certain vegetables green (see the Note to page 278); crystallise with the three ancient acids, &c. *Kirwan*.

The difference between *mild* and *caustic* alkalis, consists only in *being* or *not being* combined or at least partly saturated with *aerial acid*, viz. *fixed air*. This substance is so generally found and even produced every where in phlogistic processes continually going on in the great laboratory of Nature, that, it is no wonder that alkalies are generally found in a mild state. To obtain them free from such a combination, or in other words to render them *caustic*, artificial means must be employed, either by offering another basis which has a greater attraction to the *aerial acid*, such as the calcareous earth, already deprived of it by calcination, &c. or by expelling it from them by fire itself, the most powerful of all agents in chemical processes.

Various have been the opinions about causticity among chemical philosophers. These may be seen in Macquer's Dictionary; but since Dr. Black's Theory is now so well established, and already adopted by all rational philosophers, it would be a very useless task to enter into any explanations of the absorbed *pure fire* of Lemery, or the *acidum pingue* of Meyer.

But the essential difference between acids and alkalis, is hardly to be understood, but from their particular actions on different substances: there is no doubt but these respective

ing at the same time together, by which new compositions are made, that are called neutral salts, or *salia neutra*.

actions are produced by their proper powers of attraction, which in alkalis seems to be modified to a certain degree of activity below that of mere acids. We may complain indeed of the deficiency of our knowledge in regard to the essential cause of this phenomenon which we mean to explain by the word *attraction*; but it being the ultimate effect our knowledge can reach to, after our observation has been driven from cause to cause of all that we can discern in nature, we must rest contented with the simple deductions from such an evident and general principle, whatever may be its original cause.

When I am told that the effects of attraction depend from a *tendency* of the parts of matter to one another, or from that *avidity* or *eagerness*, with which they endeavour to unite together, expressions so often repeated among modern theorists, I cannot help thinking of those poetical ideas given by Plato in his *Convivium*, where man and woman are said to be at first united together in a single body. But, being separated afterwards by the hand of destiny, these mutilated beings find themselves now situated in a dissatisfied position, anxiously desiring to recover their former union. These emblematic fictions of a poetical imagination may produce a good effect to draw up the moral picture of human affections: but they necessarily mislead our attention from the true investigation of natural phenomena, by the false colours they bestow upon those facts which flow from physical causes, and which alone can lead us through philosophical disquisitions. Let us then banish for ever from philosophical inquiries those childish expressions of *tendency*, *avidity* and *eagerness* to reciprocal union, &c. all which suppose a deliberate action of living and sensible beings; and let us simply employ the words of attraction or *attractive powers*, to signify those *effects* or *actions* between inanimate substances, by which they follow the impulse of their natural energy, whenever they are within the sphere of each other's action. *The Editor.*

S E C T. 169. (Additional.)

Vegetable fixed Alkali. Alkali fixum vegetabile. Lat. [a].

A. Vegetable fixed alkaly, deprived of every acid, is not found on the face of the earth; but it is sometimes met with, in combination with the vitriolic acid or the muriatic, generally with the nitrous, rarely with the aerial [b].

The

[a] With regard to the origin of the vegetable fixed alkali, there are sufficient proofs that it exists already formed in plants, (*See note (a) to Sect. 174.*): and also that a portion is formed by combustion. But in each case the alkali is obtained in an impure state through the admixture of other matters which must be separated before it can be used for chemical purposes.

The *endres gravelées* are made by burning the husks of grapes and wine lees. They contain the purest alkali met with in common, and are used by the dyers.

Potash is made by burning wood and other vegetables. This alkali is much phlogisticated; and contains many foreign and saline matters, which however may be separated.

That which is obtained from the ashes of wood burned in kitchens, is the most impure of all.

On the contrary that which is got from tartar of wine, properly burned, then dissolved in boiling water and purified by filtration and crystallisation, is called *salt of tartar*. It is the best and most used in all chemical operations. *Macquer.*

[b] The *vegetable alkali* is seldom found in the earth, except in wells of towns, as at Doway: or in the argillaceous alum-

The fixed vegetable alkali (or *potasse* of Morveau) is of a powdery appearance and of a dead white colour. When pure, it is much more caustic than the neutral salt it forms with the aerial acid: and even corrodes the skin [c].

1. It changes the blue colours of vegetables into a deep green.

2. It has no smell when dry, but when wetted it has a slight lixivious odor.

3. Its taste is strongly acrid, burning, caustic, and urinous [d]. This last sensation arises from the volatile alkali it disengages from animal substances.

4. When exposed to the air, it attracts humidity, and is reduced into a transparent colourless liquor. According to Gellert, it attracts three times its own weight of water.

alum-ore of *la Tolfa*: it is found also united to the nitrous acid near the surface of the earth in *Spain*, and in the *East-Indies*, probably from the putrefaction of vegetables. *Kirwan*.

[c] Common vegetable alkali, salt of tartar, and potash were formerly considered by chemists as simple alkalis: but Dr. Black of Edinburgh has demonstrated them to be true neutral salts, arising from the combination of the vegetable alkali with the *aerial acid*. From hence it follows that the above common alkalis, even after any other extraneous substance has been extracted, must be freed from this acid by putting each in a crucible, and exposing it to a strong fire, which will dissipate this aerial acid. The alkali so purified, is to be put in a glass phial, before it is intirely cold, and kept close with a proper stopple; otherwise the aerial acid which floats in large quantities on the atmosphere, will combine again with the pure alkali. *Mongez*.

[d] The alkali must be largely diluted with water in order to be tasted: otherwise it will act on the tongue, and corrode the parts where it touches. *Macquer*.

5. It

5. It likewise attracts sometimes the aerial acid from the atmosphere, and is thereby deprived of its property of deliquescing.

6. When it is dissolved in an equal weight of water, it has an oily feel, owing to its action on the fatty parts of the skin, whence it is, though improperly, called oil of tartar.

7. In a moderate heat it melts: but in a more violent fire, it is dispersed or volatilized.

8. It is a most powerful solvent by the *dry way*: in a proper heat it dissolves *calcareous*, *argillaceous*, *siliceous* and *metallic* earths: and when the alkali is nearly equal in quantity to the earth, it forms various kinds of hard solid and transparent glass.

9. But if the alkali be in quantity three or four times that of the earth, the glass is deliquescent.

10. The mild vegetable alkali unites with the vitriolic acid with a violent effervescence, and produces vitriolated tartar.

11. With the nitrous acid, it forms the crystallizable salt, called *nitre*.

12. With the marine acid it forms a kind of salt less grateful than common salt, which is called the *febrifuge salt of Sylvius*.

13. With vinegar it forms a neutral deliquescent salt of a sharp taste, called *terra foliata tartari*.

14. With cream of tartar it forms *tartarized tartar*.

15. It dissolves sulphur, and forms the substance, called *liver of sulphur*, which is a powerful solvent of metallic substances.

17. It

17. It attacks the metals, and dissolves some of them with peculiar management. Silver, mercury, and lead, are more difficultly dissolved than gold, platina, tin, copper, and especially iron. The last gives a fine reddish saffron colour, first observed by Stahl who called it the *martial alkaline tincture*.

18. It dissolves, in the dry way, all the dephlogisticated metallic calces.

19. It unites with oils and other fat substances, with which it forms soap.

20. This alkali becomes opaque when exposed to the flame of the blow-pipe: it decripitates a long time, and forms a glassy button which is permanent in the little spoon; but is absorbed with some noise on the charcoal, when blown upon it.

See Note b to the following Section, for an account of the crystalline figure of this vegetable alkali.

S E C T. 170. (136.)

Mineral or fossil fixed alkalis, Alcalia mineralia fixa. Lat.

B. Alkali of the sea, or of common salt, Alkali salis communis, propriè minerale dictum [a].

1. Pure, *Purum.*

This has nearly the same qualities with the lixivious salt, which is prepared from

[a] This salt is not met with pure in Europe, but it is said to be found in both the Indies, not only in great quantity, but likewise of a tolerable purity: it is there collected in form of an efflorescence in the extensive deserts, a profitable trade being carried on in it for the making of soap and glass: and therefore it is very probable, that the antients meant this salt by their *natron*, or Baurach.

The calcareous earth is suspected either to contain this salt in its own composition, or else to be able to generate it from itself: but this hypothesis cannot be demonstrated. It is more probable, that the heat of the sun under the equator, and in the countries on both sides of it, evaporates the humidity, and afterwards expels the acid out of some common salt, which either is naturally mixed with the earth, or else has been deposited there through the means of certain decayed vegetables, that always contain this salt; because an earth from Palestine, which Dr. Hasselquist some years ago sent to Sweden, as a matrix of the natron, did upon trial yield nothing but a common salt: and it might, perhaps, have been taken at such a great depth, that it had not yet suffered any decomposition. But this matter wants to be more illustrated by observations, which might be best made in the East-Indies, where the greatest quantity is to be had, and also by some farther analyses of the substance. *The Author.*

the

the ashes of burnt vegetables; it is the same with the *sal sodæ*, or kelp, because the kelp is nothing else than the ashes remaining after the burning of certain herbs that abound in common salt; but which common salt, during the burning of those vegetables, has lost its acid [b].

The

[b] The mineral alkali is often combined with the *vitriolic* and *marine* acid, and also with the *aerial acid*, with which last it retains not only the name, but many of the properties of a pure alkali, because this last acid is easily expelled.

It is easily known by its crystallisation and its solubility in *two times and a half* of its weight of water at the temperature of sixty degrees.

One hundred parts of this alkali when pure, and recently crystallised, contain twenty of mere alkali, sixteen of *aerial acid*, and sixty-four of water. *Kirwan*.

The crystals of *mineral alkali*, when perfect, have a rhomboidal octaedral figure, composed of two pyramids joined by their bases, somewhat similar to the crystals of sulphur, but more flattened, and with the angle, formed at the common base of the two pyramids, less sharp. However the most common figure of these crystals is a rhombic oblique-angled decahedron, resulting from the absence of the two upper corners or tops of the pyramids. Some of these crystals are figured also in rhomboidal octahedrons, consisting of two wedge-form pyramids joined by their bases; each consisting of two scalene triangles, and two trapezoides.

But the crystals of the *vegetable alkali*, which are only produced when saturated with the *aerial acid*, have the prismatic figure of an oblong rectangular octahedron; terminated by the bases of two triangles, which form a wedge at each end. There are however some other varieties in the configuration of these as well as almost all other crystals, which justify what I have said elsewhere (Note a to page 164) about the little or no dependence at all on the configuration of mineral bodies, to constitute their specific characters. These various configurations

The properties of the mineral alkali [c] are as follows :

1. It effervesces with acids, and unites with them.
2. Turns the syrup of violets to a green colour.
3. Precipitates sublimate mercury in an orange-coloured powder.
4. Unites with fat substances and forms soap.
5. Dissolves the siliceous earth in the fire, and makes glass with it, &c. It distin-

rations of the alkaline crystals may be seen in the *Cristallographie* of Mr. Romé de l'Isle, vol. I. page 142, and following of the second edition.

The same Author in that very elaborate work (in which his great prejudices have very often run away with his discernment) speaks about the transmutation of alkalis into one another; and quotes some authorities to establish its existence. But until such processes are better ascertained, than those hinted by various Authors about the metamorphosis of the three principal acids already mentioned in the Note to p. 294, every one is entitled to draw the same conclusion I have there expressed. *The Editor.*

Mineral alkali is found in *Hungary* in marshy grounds, of an argillaceous or marly nature, either mixed with water, or crystallized and efflorescing. It is found also in *Egypt* at the bottom of lakes, and dried up by the summer's heat: and also in the province of *Suchena*, twenty-eight days journey from Tripoli, where it has the name of *Trona*; in Syria, Persia, as well as in the East-Indies and China where it is called *Kien*:

It sometimes germinates on walls, and is called by many *Aphronitron*. In its native state, is frequently mixed with magnesian earth, common salt, muriatic magnesia, and marine selenite. *Kirwan*

[c] See Note a to Sect. 174 concerning the existence of alkalies in vegetables, before their combustion and incineration,

guishes itself from the salt of the pot-ashes, by the following properties [d].

6. It shoots easily into rhomboidal crystals, that
7. Fall to powder in the air, merely by the loss of their humidity [e].
8. Mixed with the vitriolic acid, it makes the *sal mirabile Glauberi*.
9. It melts more easily, and is fitter for producing the *sal commune regeneratum, nitrum cubicum, &c.* Perhaps it is also more conveniently applied in the preparation of several medicines.
10. It is somewhat volatile in the fire.

S E C T.

[d] This mineral alkali likewise differs from the vegetable. 1. By its taste, which is less corrosive and burning. 2. By its not deliquescing. 3. By the small degree of heat it produces if calcined and afterwards added to water. 4. By its property of crystallizing by evaporating the water from its solution as is practised with neutral salts, whereas the vegetable alkali does not crystallize unless combined with a large portion of aerial acid.

[e] This alkali being a very useful commodity, and essentially necessary in a number of manufactories, many ingenious processes have been contrived and attempted to procure it at a cheap rate by decomposing the sea salt: but I am informed that till now none of these new manufactures have succeeded, except that of Mr. Turner, mentioned by Mr. Kirwan in the second part of the Philosophical Transactions for 1782. I am informed that the process consists in mixing a quantity of litharge with half its weight of common salt, which on being triturated with water till it assumes a white colour, is left to stand some hours; after which a decomposition ensues, the alkali being left alone, whilst the acid unites to the metallic calx: and this last being urged by a proper degree of fire, produces

a fine

S E C T. 171. (140.)

Volatile alkali, *Alkali minerale volatile*.

This perfectly resembles that salt which is extracted from animals and vegetables, under the name of *alkali volatile*, or *sal urinosum*, and is commonly considered as not belonging to the mineral kingdom; but since it is discovered not only in most part of the clays, but likewise in the sublimations at Solfatara near (Naples, it cannot possibly be quite excluded from the mineral kingdom [a].

Its

a fine pigment of a greenish yellow colour, whose sale pays for the most part of the expences.

Mr. Kirwan says in the place already quoted, that if perfectly dry common salt be projected on lead heated to incandescence, the common salt will be decomposed, and a *horn-lead* formed, according to Margraff. He adds also, that according to Scheele, if a solution of common salt be digested with litharge, the common salt will be decomposed, and a caustic alkali produced. And finally that the same Mr. Scheele decomposed common salt, by letting its solution slowly pass through a funnel filled with litharge. *The Editor*.

[a] Volatil alkali is frequently found in clays, doubtless in a mild state, as the help of art is required to render it caustic. It is also found united to the vitriolic, and to the muriatic acids. *Berg. Sciogr.*

It is easily known by its smell, though in a mild state; by its volatility; and by its action on copper, the solutions of which in the mineral acids, are turned blue by an addition of this alkali. It is frequently found, though in small quantities, in

Its principal qualities are that,

- a. In the fire it rises in *forma sicca*, and volatilises in the air, in form of corrosive vapours, which are offensive to the eyes and nose [b].
- b. It precipitates the solution of the mercurial sublimate, in a white powder.
- c. It also precipitates gold out of *aqua regia*, and detonates with it, because

mould, marl, clay, shistus, and in some mineral waters. It probably derives its origin in the mineral kingdom, from the putrefaction or combustion of animal or vegetable substances. *Kirwan*.

The same is caustic when uncombined with any *acid*, not excepting even the *aerial acid*. It differs from the other two alkalies in many essential particulars. 1. By its aeriform or gaseous nature. For, the volatile alkali, in a state of purity, is nothing more than an alkaline Gas diffused in water, as Dr. Priestley has demonstrated. 2. By its volatility. 3. By the nature of the salts it forms with acids, which are very different from those whose bases are formed either of the vegetable or mineral alkali. *Mongez*.

[b] Pure volatile alkali in an aerial form resembles atmospheric air, but is more heavy. Its smell is penetrating and suffocates animals. Its taste is acrid and caustic. It quickly converts blue vegetable colours to green, and produces heat during its combination with water. But if the water be frozen, it melts, producing at the same time an extreme degree of cold. It has a remarkable action on most metals, particularly copper.

This substance is obtained by the putrefactive fermentation from animal and some vegetable matters. It is this salt which causes that strong smell which is perceived in drains and privies on a change of weather. *Mongez*.

Its volatility arises from a very subtil and volatile (or phlogistic) oil which enters as a principle into its composition. *Macquer*.

d. It

- d. It has a reaction in regard to the acids, though not so strongly as other alcalies.
 - e. It tinges the solution of copper blue, and dissolves this metal afresh, if a great quantity is added [c].
 - f. It deflagrates with nitre, which proves that it contains a phlogiston.
- It is never found pure.

[c] The solution of copper by this alkali, which is of a fine blue, presents a remarkable phenomenon. For if it be kept in a well closed phial, the colour decays, and at length disappears, giving place to transparency. But on opening the phial, the surface or part in contact with the air becomes blue and the colour is communicated through the whole mass. This experiment may be many times repeated with the same success. *Editor from Macquer.*

Query. Is it the *phlogiston* of the air, or its *acid*, that produces this phenomenon? if either, or both, how can it vanish through the glass, and not be able to come in, unless the stopple be removed? does this not prove, that light and phlogiston are the very same subtle substance, but variously modified, viz. capable of pervading in a more or less quantity through glass, uniting to some substances, or flying off, according to various circumstances: and producing a variety of effects according to its density? *The Editor.*

THE THIRD ORDER.

S E C T. 172. (Additional.)

Neutral Salts. Sales neutrales. Sales medii.

ACIDS united to *alkalies* form neutral salts. These dissolved in water are no ways disturbed by the addition of an alkaly: and generally by evaporation, concrete into crystals. If by proper tests they shew neither acid nor alkaline properties, they are said to be *perfect* neutrals; but *imperfect*, when from defect in quantity or strength of one ingredient, the peculiar properties of the other more or less prevail. *Bergm. Sciag.*

The name of *neutral* given to these saline combinations, is relative to the reciprocal saturation of the acid and its base. Those produced by the union of an acid and a fixed alkali, are in a state of more absolute saturation than those which have a base of volatile alkali; and these last are still more saturated than salts with an earthy base [a]. There are however some exceptions,

[a] When a substance is said to be *united* to, or *combined* with another substance, it must be understood that both are joined

ceptions, as for instance *selenite* which has a very complete saturation of its principles.

Lastly the neutral metallic salts are most commonly the least saturated of all, and consequently it is among them that the greater number of corrosive, active, and deliquescent salts are found.

But it is observable, that these properties do not follow any settled proportion of their coherence and saturation. For it is seen that corrosive sublimate is much less soluble than marine salt, and at the same time its corrosive quality or action on many bodies is vastly greater. *Macquer.*

joined by the stronger power of attraction: but when it is said that they are contaminated by, or mixed with one another, it is only signified that their mixture is of the mechanical kind. *Berg. Sciag.* § 103.

S E C T. 173. (Additional.)

Vitriolated tartar. Alkali vegetabile vitriolatum. *Lat.*

The vitriolated vegetable alkali, or as Morveau calls it the *vitriol* of *potash*, is a perfectly neutral salt which results from the combination of the vitriolic acid with the vegetable fixed alkali. According to Bergman it seldom occurs spontaneously in nature, unless where tracks of wood have been burnt down: and Mr. Bowles quoted by Mr. Kirwan, says it is contained in some earths in Spain.

1. It requires about sixteen times its weight of water to dissolve it in the temperature of sixty degrees of Fahrenheit, and only five of boiling water.

2. It forms non-deliquescent permanent crystals [a].

3. It decrepitates when heated, but loses little of its weight [b].

[a] This salt being exposed to extreme heat melts, and at length volatilizes, but without decomposition. *Mongez.*

[b] Exposed suddenly to the flame of the blow pipe it decrepitates with noise, melts, flows on the charcoal, and leaves a yellow reddish matter which emits an hepatick smell, especially if it be melted with any acid. This mass is a true sulphur produced by the vitriolic acid and the phlogiston of the coal. The vegetable alkali reacting on this sulphur produces the hepatic sulphuris. *Mongez.*

4. It

4. It is of very difficult fusion, and precipitates the nitrous solutions of *silver*, *lead*, *mercury*, and *chalk*.

5. It is not rendered turbid by the addition of an alkali; but the acid of tartar, dropped into its solution, forms a precipitate [c].

6. One hundred parts of this salt contain about thirty-one of real vitriolic acid, sixty-three of the vegetable alkali, and six of water.

7. It is easily obtained by pouring the vitriolic acid on a solution of fixed vegetable alkali till it is saturated. Crystals of this neutral salt are then formed. This crystallization succeeds better by evaporation than by cooling, according to *Mongez*.

8. The taste of this salt is disagreeable, tho' somewhat resembling common salt.

[c] Almost all the acids act on vitriolated tartar, and decompose it, as well as combustible matters, especially charcoal. It has no action on simple earths. *Mongez*.

S E C T. 174. (Additional.)

Common nitre. Alkali vegetabile nitratum.

This is known in commerce by the name of *salt-petre*, and is also called *prismatic nitre*, to distinguish it from the *cubic nitre* of Sect. 178. It is a *perfect neutral salt*; resulting from the combination of the nitrous acid with the pure vegetable alkali of Sect. 169.

According to Bergman in his *Sciagraphia*, it is formed upon the surface of the earth where vegetables, especially when mixed with animal substances, putrify. The alkaline basis previously exists in the plants [*a*], but the origin of the

[*a*] My late worthy friend, Mr. Rouelle, demonstrator of chemistry at the *Jardin Royal* at Paris, and himself a chemist of the first eminence, evidently proved in two papers of his, read at the Royal Academy of Sciences of Paris in 1770, that both the vegetable and mineral alkalies naturally exist ready formed in vegetable substances before their combustion and incineration. The famous Mr. Margraaf had indeed published the same discovery, before Mr. Rouelle, without any knowledge of his labours on this subject; but this last communicated them, long before that publication appeared, to Messrs. Venel, Roux, and d'Arcet, having begun to work on this matter as early as the year 1748 (see *Journal de Physique* for January 1773, page 13, and following). The late Mr. A. Leroi in 1780 endeavoured by specious arguments to overthrow the conclusions of Mr. Rouelle; but Mr. Berniard a very able chemist at Paris confuted his false reasonings, by direct inferences,

the acid is not so well understood, viz. whether it lies concealed in the vegetable acid, and by means of the putrefactive process sufficiently dephlogisticating it, is evolved; or whether the purer part of the atmospheric air contains nitrous acid *fully* saturated with phlogiston, which upon the alkali being separated by the putrefaction is attracted and extricated by it, and upon losing its inflammable principle assumes its accustomed form. Nature perhaps operates in both ways; the latter however seems clearly confirmed by a remarkable phenomenon to be mentioned in Sect. 190.

As nitre is annually produced in large quantities, it cannot but sometimes be found in springs or wells, as has been observed at Berlin [b], London [c], and elsewhere [d]. Sometimes

ferences, from a variety of judicious processes, made jointly with the celebrated professor of chemistry at the Royal College of Paris, Mr. d'Arcet, brother in law and intimate friend of the said Mr. Rouelle, by which the truth of his assertions was completely established. See Mr. Berniard's *Memoir in the Journal de Physique of March 1781, page 179, and following*. The Editor.

[b] *Margraf's Opuscula*, quoted by Bergman in his *Sciagr.* Sect. 45.

[c] Cavendish in the *Phil. Transact.* for 1767 quoted by the same.

[d] Dr. Home, in his essay on Bleaching, says that nitre is found in coal mines in this island: and a friend assures me that he has obtained it from the water issuing out of coal pits. *Dr. Withering.*

Nitre is said to be found formed by nature on the surface of masses of chalk in the neighbourhood of *RocheGuyon* in France,

times it abounds in such quantities that flesh boiled in these waters turns red [e].

According

France, and in certain clays in the *East-Indies*, *China*, *Spain*, and in *Siberia*, in the cavities of rocks. *Kirwan*.

“ Nothing is more certain (say Messrs. Van Egmont and Heyman at page 149 of the second volume of their Travels, printed in 1759,) than that salt-petre is found in all the parts (of Egypt) which the inundation of the Nile reaches; but it is also seen in places, to which the water of that river does not extend. In several (of them) the surface of the earth is whitish; whereas on others, the only difference is in a saltish taste. Salt-petre can likewise be extracted from it, by only sifting and macerating it in water, then boiling it in a copper like sugar; the sediment is the salt-petre used all over Egypt.

“ The places where this earth is found, are considered as mines, and belong to the Grand Signior, and are worked on his account; so that any person embezzling it, is severely punished. In going to Cairo are several villages along the Nile, the chief employment of which is to make the salt-petre. The province of Saide particularly abounds in salt-petre, and it is an ingredient in all the gun-powder made in Egypt.”

Nitre is found very frequently in old mortar; sometimes it shoots on the surface of damp walls, and is then called by the French *salpetre de bouffage*: but old mortar often contains only nitrous selenite, which is converted into true nitre by mixture with ashes, though those ashes contain a large proportion of *witriolated tartar* and *Glauber's salt*; because these salts decompose the calcareous selenite, and form nitre by the way of double decomposition. *Kirwan*.

[e] This property of salpetre is well known to our English cooks, who employ it often for giving that agreeable lively red look to boiled meat served at table. This is a particularity not seen in the tables abroad, where such a sight would be looked upon as an indication of a ravenous taste for raw flesh, like that of wild carnivorous animals. So opposite are the ideas of beauty or deformity, of the agreeable or the disgusting

According to Mr. Kirwan, one hundred parts of nitre contain about thirty of *nitrous acid*, sixty-three of *vegetable fixed alkali*, and seven of *water*.

1. This salt has a saline cooling taste, which afterwards becomes somewhat disagreeable.
2. It is soluble in water, and requires about seven times its weight of water to dissolve it in the temperature of sixty degrees of Fahrenheit; but half its weight of boiling water is sufficient to dissolve it.
3. Its specific gravity is 1920.
4. Vegetable alkalies do not render its solution turbid: but the acid of tartar does.
5. Mixed with *marine acid* produces *aqua regia*, which dissolves gold.
6. It melts over the fire before it be red hot: but
7. If left in this melted state a long time, the acid flies off, and the alkaline basis is left behind.
8. Exposed to the fire with combustible bodies, for instance if an alive coal is put into it, or it is put in a red hot iron vessel, a detonation ensues, producing a vivid white flame [*f*], on account of the dephlogisticated

ing which arise more from habits of education, than from any natural connection with their objects, among various nations, and sets of men! *The Editor*.

[*f*] The only satisfactory explanation of this remarkable phenomenon, was first given by that indefatigable Enquirer into

phlogisticated air contained in the nitre, which combines with the phlogiston of the combustible matter.

S E C T.

into nature and most able philosopher Dr. Priestley, in the fourth volume of his important discoveries on Air, page 254: he there ascribes it to the sudden deflagration of that new kind of air, he first discovered, known by the name of *dephlogisticated air*, in which *combustible substances burn with the greatest violence*. Mr. Chaptal, professor of chemistry at Montpellier, successfully pursued the same idea, although without mentioning Dr. Priestley. He affirms that the *dephlogisticated air* contained in nitre, when urged by heat, detonates, because it unites with the *phlogiston* of the charcoal, or of the heated iron, upon which the nitre is laid: and the same happens when the *dephlogisticated air* of the calx of gold or mercury, unites in a proper heat to the *phlogiston* of the precipitating volatil alkali in the first, or of the sulphur in the second case, &c. See his account in *Journal de Physique*, vol. 22. page 61.

The celebrated professor Bergman, in a *Dissertation* on the fulminating calx of gold, exhibited to the Public in December 1769, and afterwards inserted in the second volume of his *Opuscula*, explains this detonation, by the union of the calx of gold to the phlogiston, which is let loose by heat; and says, that the alkaly is thus suddenly expanded so as to make that explosion: but he acknowledges, that the calx of platina, precipitated by the same volatil alkali does not detonate. This of course seems to prove that there must be some other cause for these phenomena.

Mr. Macquer, in the second edition of his Dictionary published about ten years after the above dissertation of Bergman, speaks of a new *sulphur of nitre* whose imaginary existence has never been ascertained, as it is said to be instantaneously kindled in the very act of its formation; to this he attributes the phenomenon of detonation. He mentions afterwards the explanation of Stahl, who thought that the water, or rather the acid of nitre is violently inflamed by the superabundance of

S E C T. 175. (Additional.)

Digestive Salt. Salt of Sylvius. *Alkali vegetabile Salitum. Sal digestivus Sylvii.*

This neutral salt is sometimes though rarely met with on the earth, generated perhaps, as professor Bergman observes, by the destruction of animal and vegetable substances.

According to Macquer this salt has been very wrongly called *regenerated marine salt*: and the epithet of *Febrifuge* has also been given to it, without any good reason to evince that it

of the phlogiston in the act of detonating: and finally says that the aeriform elastic substances contained in nitre, may be the cause of such sudden explosions or detonations.

After all it seems that Doctor Priestley's explanation of this phenomenon pursued by Mr. Chaptal, is the better supported by collateral facts: but it remains still to be understood, how the immediate action of each cause upon one another is performed.

Whenever we come to be better acquainted with the nature of *elementary fire*, we may in all probability account in a compleat and satisfactory manner for these and many other phenomena, in which this powerful agent of nature has undoubtedly the greatest share. And if we allow with Dr. Crawford, that phlogiston is always expelled by the introduction of fire into those bodies where it is contained, we may form some idea of the sudden explosion or detonation of these substances, when acted upon by it in a more intimate contact with one another. *Editor.*

has

has such a property. But Mr. de Morveau calls it *muriate de potasse* with great propriety.

This salt is produced by a perfect combination of the *vegetable alkali* with *marine acid*. It has been wrongly confounded with common salt: but

1. Its flavour, though saline and sharp to the taste, is very disagreeable.
2. Its specific gravity is 1836 according to Kirwan.
3. It decrepitates in the fire, by which it also melts.
4. It may be volatilised by fire, without being decomposed.
5. It dissolves in three times its weight of water, either hot or cold.
6. When urged by the blow-pipe on a piece of charcoal, it exhibits nearly the same phenomena as common salt.
7. Dissolved in nitrous acid, it makes *aqua regia*.
8. With the nitrous solution of silver, it takes a cloudy appearance.
9. The acid of tartar causes a precipitation from its solution. But
10. Neither fixed alkali, nor the mixture of marine selenite make any precipitation in its solution.
11. One hundred parts of this neutral salt, contain about thirty of real marine acid: sixty-three of vegetable alkali, and seven of water.

It is found in some bogs in Picardy, and in some mineral waters at Normandy, according to Monet, quoted by Kirwan: Mongez adds also the sea water as containing this salt, and that it is never found in large quantities, although its component parts are abundantly produced by nature.

S E C T. 176. (Additional.)

Mild vegetable Alkali. *Alkali vegetabile aeratum*. Lat. Alkali végétal aéré. French.

This salt was formerly considered as a pure alkaly, known by the name of *potash*, and *salt of tartar*: but since the discovery of the *aerial acid* (Sect. 167), it is very properly classed among the neutral salts: and ought to be called *aerated potasse*, the epithet *aerated* indicating much better the nature of its neutralising acid, than the uncouth and improper expression of *Mephitic* adopted by the French which always conveys a disgusting idea of putrescence by no means applicable to the aerial acid. But of all the languages of Europe none is so full of indelicate terms as that of our (so called) *polite* neighbours, the Italians only excepted.

This

This neutral salt results from a combination of the *vegetable alkali* with the *aerial acid*: and is hardly ever found native, unless in the neighbourhood of woods destroyed by fire. See *Note a to Sect. 174 concerning the existence of alkalies in vegetables, previously to their combustion and incineration.*

In the year 1774, at Douai in Flanders, a spring was discovered surrounded by a wall, whose waters, besides other impregnations, contained eleven grains of this mild vegetable alkali in a pint.

Although this salt is a neutral one, it always possesses a superabundance of alkaly, of which it displays the properties, though with less efficacy than pure alkalies, viz.

1. It effervesces with acids, which are stronger than the *aerial*, and of course expel it from its union with the alkali.
2. Turns green the vegetable blue colours.
3. And produces an urinous alkaline taste in the mouth.
4. It is dissolved in four times its weight of cold water, and in a less quantity if it be hot.
5. It fuses on the fire, looses its aerial acid, leaving behind the pure vegetable alkali.
6. It serves as a flux to earthy substances: and
7. Is decomposed by the *ponderous* and the *calcareous* earths, which have a greater affinity to the *aerial acid*, than to the vegetable alkali.

8. On

8. On being exposed, on a piece of charcoal, to the flame urged by the blow-pipe, it melts, and is absorbed by the coal; but,
9. In the metallic spoon, it forms a glassy bead, which becomes opake when cold.

S E C T. 177. (126.)

Vitriolic acid saturated with mineral alkali.
 Glauber's salt. *Alkali minerale vitriolatum.*
Sal mirabile Glauberi. Alkali minéral vitriolé, (or vitriol de soude, according to Mr. Morveau) French [a].

This is a neutral salt, prepared by nature,
 (as well as by art) containing more or less
 of

[a] This salt results from the combination of vitriolic acid with mineral alkali. Its properties come near to those of *vitriolated tartar* in Sect. 173, from which it only differs on account of its base.

1. Its flavour is cooling, but it
2. Is of a very bitter taste.
3. Its crystals, which are of various forms (all derived from a rectangular octahedral prism, ending in a kind of a wedge at each end) effloresce when exposed to the air; and by heat, they lose half their weight.
4. Melts in the fire: and when it is urged considerably,
5. It is volatilized.
6. It dissolves in four times its weight of cold water; and only in three times, if in the temperature of sixty degrees of Fahrenheit. But,

of iron, or of a calcareous earth, from which arises also some difference in its effects, when internally used. It shoots easily into prismatical crystals, which become larger in proportion to the quantity of water evaporated before the crystallisation. When laid on a piece of burning charcoal, or else burnt with a phlogiston, the vitriolic acid discovers itself by the smell resembling the *hepar sulphuris*.

It is found in a dissolved state in springs and wells [b], and in a dry form on walls, in such places where aphronitrum has effloresced through them, and the vitriolic acid has happened to be present; for instance, where marcasites are

7. In warm water, it dissolves in an equal weight.
8. The nitrous and marine acids, and even the caustic fixed vegetable alkali, decompose this salt, according to Bergman, on account of their double affinities.
9. On the charcoal, it is fused by the flame urged by the blow pipe, and leaves behind an yellow, or reddish mass, (as the vitriolated tartar of Sect. 173 does) which gives out an hepatic smell, particularly if a little vitriolic acid be added to it. This mass is a true *sulphur*, produced by the vitriolic acid united to the phlogiston of the charcoal, and by the reaction of the alkali on the sulphur, an *hepar sulphuris* is then produced, as its smell indicates.
10. According to Kirwan, 100 parts of this salt contain about fourteen of the real vitriolic acid; twenty-two of the mineral alkali; and sixty-four of water.

[b] Some of the lakes in Siberia and Astracan, and many springs in other places, contain this salt, *Berg. Sciag.* Sect. 47. It is found in the sea water, and also in the earth at several parts of *Dauphiné* in France, and in *Lorraine*; and sometimes it germinates on the surface of the earth, according to *Monet*, quoted by *Kirwan*.

roasted

roasted in the open air. This salt is often confounded with the aphronitrum, or mild mineral alkali; and a learned dispute once arose, which of these salts ought with the greatest propriety to be called natron, *Baurach veterum*, *sal mirabile*, or Epsom salt, whereas it might easily have been decided by chemical experiments, if their qualities had been regarded, in preference to their figures or their native places.

.....

S E C T. 178. (Additional)

Cubic, or rather quadrangular Nitre. *Alkali minerale nitratum*, Lat. *nitre cubique*, French. (*Nitre de Soude* of Morveau).

This is the neutral salt which results from the combination of *mineral alkali* with *nitrous acid*. It has almost all the characters of *prismatic* or *common nitre* (Sect. 174), from which it only differs on account of its base; and takes its denomination from the figure of its crystals, which appear *cubic*. But it should be called *quadrangular nitre*; because its crystals are truly Rhomboidal, their obtuse angles being of about 100 degrees, and the acute ones of 80. For want of precision in observing this small difference, this nitre has been called *cubic*.

This salt rarely occurs, but where marine plants putrify. According to Bowles, quoted by Kirwan, it is found native in Spain.

1. Its specific gravity is = 1870.
2. Exposed to the air, it is more alterable, and attracts moisture more powerfully than prismatic nitre.
3. According to Mongez, it requires only twice its weight of cold water to be dissolved: but Kirwan says, that in the temperature of sixty degrees of Fahrenheit, three times its weight of water are sufficient for its solution.
4. Exposed to the flame of the blow-pipe, it melts like common prismatic nitre, and remains fixed on the metallic spoon; but if put on a piece of charcoal, takes flame by the addition of its phlogiston, making a kind of decrepitation. But, according to Mongez,
5. Its flame is *yellow*, instead of the *blue* that is given by the prismatic nitre in similar circumstances.
6. According to Kirwan, the vegetable fixed alkali decomposes, it, without forming a visible precipitate in its solution.
7. Neither does the tartarous acid precipitate any thing from it.
8. The *vitriolic* acid expels from it the *nitrous*, and forms *Glauber's* salt.
9. With the marine acid, it forms *aqua regia*.

10. According to Kirwan, one hundred parts of quadrangular nitre, contain about 29 of *nitrous acid*, 50 of mineral alkali, and 21 of water.

S E C T. 179. (129.)

Common Salt, or Sea-Salt. *Alkali minerale salitum. Sal commune*, Lat. *Sel commun, Sel de cuisine*, French.

This salt shoots into cubical crystals during the very evaporation; crackles in the fire, and attracts the humidity of the air [a].

A.

[a] This is a perfect neutral salt, composed of marine or muriatic acid, saturated with mineral alkali. It has a saline but agreeable flavour.

It requires about four times its weight of cold water to be dissolved, and nearly the same quantity of boiling water. *Macq.* But according to Kirwan, it only requires 2,5 its weight of water to be dissolved in the temperature of sixty degrees of Fahrenheit. This salt always contains some part formed with a calcareous base; and, in order to have it pure, it must be dissolved in distilled water; then a solution of mineral alkali is to be poured in it, until no white precipitation appears; then by filtrating and evaporating the solution, a pure common salt is produced. *Macq.*

Its figure is perfectly cubic, and those hollow pyramids, or *tremies* as the French call them, as well as the parallelepipeds formed some times in its cristallifation, consist all of a quantity of small cubes disposed in those forms. *Macq.*

Its decrepitation on the fire, which has been reckoned by some as a characteristic of this salt, although the *vitriolated tartar*,

A a 3

nitreus

A. Rock salt, fossil salt. *Sal montanum*. Occurs in the form of solid strata in the earth [b]:

1. With

nitrous lead, and other salts, have the same property, is owing chiefly to the water, and perhaps also to the air of its crystallisation. *Macquer*.

Its specific gravity is 2120. *Kirwan*.

The acid of tartar precipitates nothing from it.

One hundred parts of common salt contain thirty-three of real acid, fifty of mineral alkali, and seventeen of water.

It is commonly found in salt water and salt springs, in the proportion of even thirty-six *per cent*.

It is found also in coals, and in beds of gypsum. *Kirwan*.

This salt is inalterable by fire, though it fuses, and becomes more opake: nevertheless a violent fire with the free access of air, causes it to evaporate in white flowers, which stick to the neighbouring bodies. *Macquer*.

It is only decomposed, as *Macquer* affirms, by the *vitriolic* and *nitrous* acid; and also by the *boracic* (or *sedative*) salt of Sect. 165. But although nitre is decomposed very easily by arsenic, this neutral marine salt is noways decomposed by the same. See note e to Sect. 170, concerning its decomposition by the calx of lead. According to *Mongez*, the fixed vegetable alkali, when caustic, decomposes also this marine salt.

It preserves from corruption, almost all sorts of animal food much better for use than any other salt, as it preserves them without destroying their taste and qualities; but when applied in too small a quantity, it then forwards their corruption. *Macquer*.

[b] Of all natural salts, this is the most abundantly furnished by Nature in various parts of the world; being found in large masses, occupying great tracts of land. It is generally formed in strata under the surface of the earth, as in Hungary, Moscow, Siberia, Poland, Calabria, Egypt, Ethiopia, and the East Indies. In England, the salt mines at Northwich are in a high ground, and contain it in layers or strata of various colours, of which the yellow and brown are the most plentiful, as I have observed on the spot, which I visited in June

1782.

1. With scaly and irregular particles. *Sal montanum, particulis indeterminatis.*

a. Grey, and

b. White [c], these are the most common, but the following are scarcer.

c. Red.

d. Blue, and

e. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.

2. Crystallized rock salt. *Sal montanum crystallizatum. Sal gemmæ.*

a. Transparent, from Cracow in Poland [d].

1782, in company with my worthy and learned friend Mr Volta, professor of Natural Philosophy in the University of Pavia, and well known by his great abilities, and many discoveries in that branch of knowledge. The mine into which we descended, was excavated in the form of a vast dome, or vault under ground, supported by various columns of the salt, that were purposely left to support the incumbent weight. And, the work-men having lighted a number of candles all round its circumference, it furnished us with the most agreeable and surprising sight, whilst we were descending in the large tub, which serves to bring up the lumps that are broken from the mine, &c. See the description of the famous salt-mines of Wieliczka in Poland, by Mr. Berniard in the *Journal de Physique*, vol. 16. for 1780, pag. 459, in which the miraculous tales concerning those subterraneous habitations, villages, and towns, are reduced to their proper magnitude and estimate. *The Editor.*

[c] From the Transilvanian and Hungarian salt-mines. *Brunnich.*

[d] And also from Transilvania. Sometimes there are drops of water included in them. The various kinds of salt from the Polish mines are described by Dr. Schober in the *Hamburg Magazine*. Those of Transilvania, will appear in the next volume of the Danish Royal Society of Sciences, among my historical account of the mines of that country. *Brunnich.*

S E C T. 180. (130.)

B. Sea-Salt. *Sal marinum.*

This salt is produced also from sea-water, or from the water of salt-lakes, by evaporation in the sun, or by boiling.

The seas contain this salt, though more or less in different parts [e]. In Siberia and Tary,

[e] The method of extracting the salt from sea water, consists in evaporating the water either by fire after it is put on large flat pans of lead, or by letting it evaporate by the heat of the sun in hot climates. Several parcels of flat ground under the mark of the high tides, and properly furrounded by dikes, are disposed, near the sea, into many compartments, the last of which are well lined with clay, and properly beaten in an even horizontal surface. So that when the sea-water is allowed to run into these, after it has partly evaporated in the former ones, the heat of the sun in a few hours evaporates it enough to crystalize the salt, which falls to the bottom, and is drawn out with a flat piece of board at the end of a pole, &c.

But in the cold climates, much labour and fuel may be spared, by letting the sea water stand to freeze; and after separating the ice, which is only formed of the watery particles, the remaining brine contains a much larger quantity of salt, which may be very soon evaporated by fire. This method, as I have been informed by General Baur, has been already practised with great success in Russia, and perhaps it is also now used in various other parts of the North.

It is said (vol. I. of Romé de l'isle's *Crysallograph*, pag. 375) that the salt water in the Baltic-sea, contains one sixty-fourth part of its weight of salt; that of the sea between England and Flanders, contains the 32th part; that of the coasts of Spain,

tary, there are lakes that contain great quantities of it [f].

S E C T. 181. (131.)

C. Spring Sea-Salt. *Sal fontanum* [g].

Is produced by boiling the water of the fountains near Halle in Germany, and other places [b].

Near the city of Lidkoping, in the province of Westergotland, and in the province of Dal,

Spain, one ounce in the pound; and that between the Tropics, one ounce and a half, or even two ounces, viz. one eighth of the whole. From this may be seen the great advantage of separating the brine of the sea-water in cold climates, by the above freezing method, before it be set over the fire for evaporation. *Editor.*

[f] The lake Yelton, beyond the River Volga, supplies all Russia with salt. See Philos. Transf. vol. 77. and Forter's Introduction to Mineralogy, page 32.

[g] Salt fountains are very common in various parts of Europe, and elsewhere, so that hardly any kingdom is absolutely divested of one or other of the kind. At least, we know that such salt springs are found in Lorraine, Alsatia, Franche-Comté, and Gascony, Provinces of France; in the Palatinat of the Rhine, Spira, Hesse, and Lunebourg in Germany; Halle in Saxony; in Ostrogothland, Westmanland, &c. &c. *Mongez.*

[b] These salt waters are evaporated, first by raising the water into reservoirs, from whence they are dispersed through troughs with holes, and fall down on heaps of thin branches of wood, in order to expose a multiplicity of surfaces to evaporation by the action of the air, in long galleries. The remaining brine is evaporated in large flat pans of lead, till the salt is formed, as was above said of the sea salt.

The Editor.
salt-

salt-springs are found, but they contain very little salt: and such weak water is called *solen* by the Swedes [*i*].

S E C T. 182. (139.)

Borax [*a*].

This is a peculiar alkaline salt, which is supposed to belong to the mineral kingdom, and cannot be otherwise described, than that it is
 dissoluble in water, and vitrescible;
 that it is fixed in the fire; and melts
 to

[*i*] This division of the natural common salts is generally adopted, and not without reason, since the taste of all differs a little from one another, which depends on the less or greater mixture with heterogeneous substances. For out of the purest of these salts, a little of an earthy substance may still be precipitated, which dissolves in acids, and seems to be of a calcareous nature. How common salt is produced in the earth, and from whence the great store of it in the ocean is supplied? naturalists have laboured in conjecturing, but have not proceeded farther. *The Author.*

[*a*] This is an imperfect neutral salt, composed of mineral alkali, nearly saturated with the *boracic acid* already described in Sect. 165. Its discovery in Europe has been mentioned in Note *a* to that Section. It is said also, that borax has been found in some coal-pits of Saxony. This fact is mentioned by Mr. Kirwan; and Mr. Mongez says that it is found naturally formed and crystallized on the bottom of the lake *Neebal*, in the *Semhal*, a province of the kingdom of Thibet; in some caverns in Persia, in the Mogul's empire; in the island of Ceylon

to a glass, which glass is afterwards dissoluble in water [b].

Many

Ceylon as well as in the neighbourhood of Halberstadt in the Lower Saxony.

When the Author published this mineralogy, the same ancient doubts continued to subsist, viz. whether borax was a factitious or natural substance: but since the year 1772, when Mr. d'Engestrom recieved from Mr. Grill Abrahamson, some tincal sent to Sweden in crystalline form, as dug out of the earth in the kingdom of Thibet, where it is called *pounxa*, *my poun* and *houi poun*, and the discovery of Mr. Hoeffler in the lagoons of Tuscany, mentioned in the note to Sect. 165; it is now beyond all doubt, that this neutral salt is a natural production, as Mr. Kirwan asserts.

It is remarkable, that near 40 years ago, doctor Hill, in his notes to *Theophrastus's Treatise on Stones*, asserted that borax was a salt made by evaporation of an ill-tasted and foul water, of which there were springs in Persia, Muscovy, and Tartary. But he was hardly believed, on account of the many bold and groundless assertions, of which he had been found guilty in almost all his numerous works. Mr. Beaumé at Paris pretended to have discovered the method of making the sedative salt (and of course the borax, which is a combination of this salt with mineral alkali) by a long maceration of greasy and earthy substances; but nobody has yet been able to verify this fanciful discovery. *The Editor.*

[b] Borax, in the state in which it is naturally found,

1. Requires about eighteen times its weight of water to dissolve it, in the temperature of sixty degrees of Fahrenheit.
2. Its specific gravity is = 1740.
3. Its taste is astringent and styptic: and
4. It effloresces when exposed to the air.
5. It does not effervesce with the mineral acids, except they be heated; and then but slightly.
6. When heated, it loses four-tenths of its weight.
7. If vitriolic acid be added to a solution of borax, the sedative salt will be separated, and swim on the surface

in

Many experiments have been made with it, in order to discover its origin and constituent parts, of which an account is given in chemical books [c] ; and its following qualities are to be observed.

1. It swells and froths in the fire, as long as any humidity remains in it ; but melts afterwards very easily to a transparent glass, which, as it has no attraction to the phlogiston, keeps itself in the form of a pearl on the charcoal, when melted with the blowpipe.

2. It

in the form of white scales (see note *b* to page 316). The filtrated liquor will, by evaporation, yield *Glauber's salt* Sect. 177. *Kirwan*.

[c] The unrefined borax which is brought to Europe under the name of *tincal*, looks like soft soap, is fat, and covers or encrusts the borax-crystals. The mine-master Mr. Swab, who has had an opportunity of making experiments upon this *tincal*, has published them in the *Acts of the Royal Academy of Sciences at Stockholm* for 1756. He says, that he has found in it a martial earth, and a fat substance, which, to smell and other circumstances, comes nearest to a mineral fat : as likewise, that pure borax does not yield any *hepar sulphuris*, when united with a phlogiston and a vitriolic acid ; from which he concludes, that borax is prepared from its own particular mineral substance.

Professor Pott and Mr. d'Henouville have very carefully examined the refined borax ; and from their experiments, which have been published, it is evident, that it is of a particular nature ; however, there remains to be known for certain, from what it is prepared by the Indians : for, if it is produced from a mineral substance, as is very probable, there must exist other mixtures and compositions, which are yet unknown to the learned world.

2. It changes the syrup of violets into green ; and precipitates the solution of allum, and that of metals, made with acids [d].
3. It unites with mineral acids from which shoot very fine and subtile hair-like crystals, called *sal sedativum* (Sect. 165.) This mixed with *litmus*, or *succus heliotropii*,

I have also found in the *tincal*, small bits of leather, bones and small pebbles, whence there is no certainty to be concluded on from its examination ; but, if it should happen, that it is prepared from animal substances, it must be allowed, that nature has formed an alkaline salt in the animal kingdom, which answers to the fixed acid salt in the human urine, called *sal fusibile microcosmicum*, and which has been first accurately described by Mr. Margraff, in the Memoirs of the Academy of Berlin.

Some years ago a report was propagated from Saxony, that somebody had there discovered a substance out of which borax could be made, and also the art of preparing it : but nothing more has ever transpired since, than that the author shewed it in secret to his friends, and gave a description of it, which only was intended to mislead them, if he really did possess the art. *The Author.*

[d] One hundred parts of purified borax contain thirty-two of real boracic acid, seventeen of mineral alkali, and forty-seven of water ; but of the mineral alkali, only about five parts are saturated ; and hence, in many cases, borax acts as an alkali. *Kirwan.*

Borax takes nearly an equal weight of acid (the boracic acid) before the alkaline properties intirely disappear. *Berg. Sciagr.*

From some experiments lately made, I found that both *tincal* and purified borax, required twice their weight of sedative salt, (the *boracic acid*) to neutralize them perfectly, so that they would no longer change vegetable blues to a green colour. *Withering.*

and

and the syrup of violets, discovers marks of acidity [e].

4. When it has been united with the vitriolic acid and a phlogiston, no *hepar sulphuris* is produced.
5. After being refined, it shoots into irregular figures: but the crystals, which form themselves after the first operation, and are called *borax*, consist of flat octagonal prisms, flat at the extremities, and with their angles cut off or truncated [f].

[e] See Sect. 165.

[f] Borax is imported from the *East Indies* to Europe, in a very impure state, in the form of large flat hexangular, or irregular crystals, of a dull white greenish colour, greasy to the touch, or in small crystals, cemented together, as it were by a rancid, yellowish, oily substance, intermixed with marls, gravel, and other impurities. In this state, it is called *chryso-colla* or *tincal*. Kirwan.

In all probability, these oily substances are purposely mixed with tincal by the Indians, to hinder its efflorescence or decaying, on being exposed to the air, and this seems to have furnished the mistaken idea to Mr. Beaumé for the pretended discovery of making borax out of fat substances, as above mentioned, at the end of *note a*. *The Editor*.

S E C T. 183. (Additional.)

Mild mineral alkaly. Natron, the Nitre of the ancients. *Alkali minerale aeratum, seu acido aereo saturatum.*

This neutral salt is a combination of the *mineral alkaly* with the *aerial acid* or *fixed air*. It is found plentifully in many places, particularly in Africa and Asia, either concreted into crystallized strata, or fallen to a powder; or efflorescing on old brick walls; or lastly, dissolved in springs. It frequently originates from decomposed common salt. I am not ignorant that the acid of common salt adheres strongly to its basis, so as not to be expelled by fire; but perhaps the vicissitudes of the atmosphere acting for ages, may be more powerful. In immense plains covered over with this alkaly, scarcely any common salt is found upon the surface, but the deeper you dig, the more it is contaminated by it, the common salt being yet undecomposed for want of access of air. *Bergman Sciagr.*

This is an imperfect neutral salt, and was formerly considered as a pure alkali, but the discovery of the *aerial acid* (§ 167.) has shewn the mistake.

1. It has nearly all the properties of mineral alkali (§ 170.) but with less energy.

2. The

2. The vegetable blue colours are turned green by this salt; it effloresces with acids; and has an urinous taste.
3. It is soluble in twice its weight of cold water, but if the water is hot, an equal weight is sufficient for its solution.
4. It effloresces when exposed to the action of the atmosphere.
5. It fuses easily on the fire, but without being decomposed.
6. Facilitates the fusion of vitrifiable earths, and produces glass more or less fine, according to their qualities.
7. It is decomposable by lime and ponderous earth, which attract the aerial acid.
8. And also by the mineral acids; but these expel the aerial acid of this salt, by seizing its alkaline basis, *Mongez.*

Wallerius confounds this salt with the *Aphrontirum* of Sect. 215. and calls it *Halinitrum*, when it contains some phlogiston. It is often confounded also with the *sal-petre d'houffage* of Sect. 174. and that of Sect. 178. Mr. Kulbel, quoted by the same Wallerius, showed that it exists in some vegetable earths, and takes it to be the cause of their fertility; but this only can be on account of its combination with the oily parts of them, and forming a kind of soap, which is miscible with the watery juices, the whole upon the principle already stated in Sect. 34, and more fully treated of in Rozier's *Dictionnaire d'Agriculture* in French. *The Editor.*

S E C T. 184. (Additional)

Vitriolic ammoniac. *Alkali volatile vitriolatum.*

This neutral salt was called *secret salt of Glauber*, and is a combination of the volatile alkali, with vitriolic acid. It is scarcely found any where, but in places where the phlogisticated fumes of vitriolic acid arise from burning sulphur, and are absorbed in putrid places by the volatile alkaly [a]. Thus at Fahlun the acid vapour from the roasted minerals, produces this salt in the necessary-houses. It is sometimes also formed in the craters of Volcanos. *Bergman Sciagr.* [b].

i. This

[a] As volatile alkaly may be obtained in large quantities from pit-coal, and produced by processes not dependant upon putrefaction, there is reason to believe that the vitriolic ammoniac may be formed in several ways not noticed by this author. *Wibering.*

[b] It is said to have been found in the neighbourhood of Volcanos, particularly of *Mount-Vesuvius*, where, indeed, it might well be expected: yet its existence seems dubious, since Mr. Bergman could scarce find any trace of it among the various specimens of salts from *Vesuvius*, which he examined. The reason probably is, that the vitriolic acid disengaged by the combustion of sulphur, is in a phlogisticated state: and all its combinations in this state, are easily decomposed by the marine acid, which plentifully occurs in Volcanos.

1. This salt is of a friable texture, and has an acrid and urinous taste.
2. Attracts the moisture of the atmosphere.
3. Is very soluble in water, it requiring only twice its weight of cold water, or an equal weight of boiling water, to be dissolved.
4. It becomes liquid on a moderate fire: but if urged,
5. It becomes red hot, and volatilizes.
6. The nitrous and muriatic acid decompose this salt by seizing the volatil alkali. But
7. Lime, ponderous earth, and pure fixed alkali, set the volatil alkali free, and combine with the vitriolic acid.
8. According to Kirwan, *one hundred* parts of this salt contain about 42 of real vitriolic acid: 40 of volatil alkali; and 18 of water.

This vitriolic ammoniac is easily known; for if quick-lime, or fixed alkali be thrown into its solution, the smell of the volatil alkali is perceived; and if this solution be poured into that of chalk or ponderous earth by the nitrous acid, a precipitate will appear. *Kirwan.*

It is also said to be found in the mineral lakes of *Tuscany*, which is much more probable: as the vitriolic acid when united to water, easily parts with phlogiston, and recovers its superiority over other acids.

It is said also, that this neutral salt is found on the surface of the earth in the neighbourhood of *Turin*. *Kirwan.*

S E C T. 185. (Additional.)

Nitrous Ammoniac. *Alkali volatile nitratum.*

This is a neutral salt, which results from the combination of the *nitrous acid* with the *volatile alkali*. It is frequently found in the *mother-liquor* of *nitre*. When mixed with a fixed alkali, the volatile betrays itself by its smell.

1. It is of a friable texture, of a sharp bitter ; and of a nitrous, or cooling taste.
2. According to Mongez, it attracts the moisture of the atmosphere ; but Romé de l'Isle asserts, that its crystals are not deliquescent ; the experiment may be easily tried, and the truth ascertained.
3. It is soluble in cold water ; but half the quantity of water, if boiling, is sufficient for dissolving it.
4. It liquefies on the fire, and afterwards it becomes dry.
5. It detonates with a yellow flame, before it is red-hot : and what is peculiar to this salt, it needs not, like common nitre, the contact of any combustible matter for its detonation, from whence it appears that the volatile alkaly itself possesses a great share of phlogiston.

B b z

6. Its

6. Its component parts, viz. the nitrous acid and the volatile alkali, are not very intimately united : and of course,
7. It is easily decomposed by all the substances that have any affinity to either of them.
Mongez.
8. Mixed with the muriatic acid it makes *aqua regia*.
9. One hundred parts of this neutral salt, contain 46 of nitrous acid, 40 of volatile alkali; and 14 of water, as Mr. Kirwan thinks,

S E C T. 186. (132 and 141,)

Native salt ammoniac. *Sal ammoniacum naturale*.

The muriatic (or marine) acid saturated with a volatile alkali. *Acidum salis communis alcali volatili saturatum* [a].

It

[a] This is a perfect neutral salt, resulting from the combination of marine acid with volatile alkali.

1. Its taste is sharp, acrid and urinous; and it
2. Has a peculiar property not found in any other salt, viz.
3. It is tough in a certain degree, being capable of a very sensible flexibility, without breaking.
4. It is soluble in water: and produces a great cold with ice.
5. According to Mr. Mongez, it requires six times its weight of cold water to be dissolved; but boiling water dissolves

It is of a yellowish colour, and is sublimed from the flaming crevices, or fire-springs, (*eld brunnarne*) at Solfatara near Naples [*b*].

dissolves an equal weight of this salt. According to Kirwan 3,5 times its weight of water at the temperature of sixty degrees, are sufficient for its solution.

6. Is very volatile in the fire.
7. Lime, calcareous earth, and fixed alkali, decompose this salt, by setting free the volatile alkali: on the contrary,
8. The vitriolic and nitrous acid seize the alkaline base, and disengage the marine acid.
9. Its specific gravity, according to Kirwan, is = 1420.
10. It makes *aqua regia* when mixed with nitrous acid.
11. This salt dissolves copper: and
12. Wholly evaporates, when laid on a hot iron.

[*b*] If that hypothesis could be proved true, which holds that volcanos and subterranean fires arise from slates, formed from vegetables, animals, and the *humus ater* or mould, mixed together (See the Author's note to Sect. 203.), the origin of the sal ammoniac at Solfatara would easily be discovered: since we know that petrifications discover a principle within them, which contains the *sal urinosum*. *The Author.*

Ammoniacal salt is also found efflorescent on the surface of the earth, or adherent to rocks in a powdery form; and sometimes as hard as stones, in Persia, and in the country of the Kalmuks. *Mongez.*

It is found native of different colours, grey, black, green, and red, in the neighbourhood of Volcanos, in the caverns or grottos of *Puzzuoli*, and in the mineral lakes of *Tuscany*, in some mountains of *Tartary* and *Thibet*, and also in various clays. *Kirwan.*

S E C T. 187. (Additional.)

Aerated (or mild) volatil alkali. *Alkali volatile aeratum.*

This neutral salt results from the combination of volatile alkali united to the aerial acid. It was formerly considered as a pure alkali, but the discovery of the *aerial acid* (or *fixed air*) has shewn it to be a true neutral salt, though imperfect; as it retains still all the properties of an alkaly, though in a weaker degree, on account of its combination with the aerial acid, which is itself the most weak of all acids, and of course other stronger acids easily dislodge it from its base, and from various ammoniacal salts.

1. This imperfect neutral salt has an urinous taste, and a particular smell, which is very penetrating, though less pungent than the pure volatile alkali of Sect. 171: and in the same manner, it turns the blue vegetable juices green. But it
2. Effervesces with other acids stronger than the aerial one, which the pure or caustic volatil alkali does not.
3. It sublimes very easily with a small degree of heat:
4. And dissolves in twice its weight of cold water; but in a lesser quantity, when this last is boiling hot.

5. It

5. It acts on metallic substances, chiefly on copper, with which a blue colour is produced.

According to Bergman, this salt was found in a well in London (Phil. Transf. for 1767), at Frankfort on the Mein, and at Lauchstadt. Mess. Hierne, Henkel, and Brandt, have found also this salt in the vegetable earth, in various kinds of Argill, and in some stony substances. Mr. Vozel found it also in some of the incrustations at Gottingen; and Mr. Malouin in some acidulous waters of France. *Mongez.*

SECT. 188. (Additional.)

Observations on the preceding fossil neutral salts.

The four neutral salts already described in Sect. 176, 182, 183, and 187, viz. the Borax and the three aerated alkalis are called *imperfect*, whilst the other neutral salts have acquired the name of *perfect*, because these last do not exhibit any of the distinguishing properties of their component parts. The three aerated alkalis have a very distinct alkaline character, as they turn blue-vegetable juices green, though not of so vivid a colour as the caustic alkali does: and the borax is capable of receiving almost an

equal quantity of its sedative acid, without losing all its alkaline properties.

In general, those neutral salts consisting of fixed alkalies combined with acids, are more saturated than those composed of volatile alkali, called *ammoniacal salts*; or those called *aerated*, which last are only composed by the combination of the *aerial acid*, united to any alkaline or earthy base.

The *aerated* alkalis are called also by the name of *mild* alkalis, because they possess no longer that sharp corroding quality, which they exhibit when deprived of the *aerial acid* or *fixed air*, in which case they are termed *caustic alkalis*, as has been explained in the note to page 327.

These *aerated* alkalis differ also from the *caustic* ones, not only on account of the mildness of their taste, from which comes their epithet of *mild alkalies*, but also by their property of crystallizing, (See N° 4 and 5 of Sect. 167), and by their effervescing with other acids, which expel the *aerial one*, the weakest of all acids we know.

There are many other observations which might be properly made in this place, concerning the various properties and peculiar phenomena of neutral salts: but as they would considerably augment the bulk of this Section, the curious reader is referred to the ample descriptions of them to be found in Macquer's Dictionary, under the respective titles of *Sels neutres, chaux terrestre*, and *causticité*, &c. The Editor.

T H E

THE FOURTH ORDER.

Earthy Neutral Salts, *Sales medii Terrestræ* [a],

S E C T. 189. (124.)

Calcareous earth combined with vitriolic acid. Vitriolated calx. Selenite. *Gypsum*. See Sect. 13. and following [b].

S E C T.

[a] The compounds of earths and acids, which possess solubility as mentioned, N° 2 and *Note g* to *page* 10, are decomposed and precipitated by mild, but not by phlogisticated alkalis. *Berg. Seag.* § 57.

[b] The gypsum, or plaster, is not only found dissolved in various waters; but also, in many places, it forms immense strata. It is placed by all mineralogists among the earths, which it greatly resembles; but it rather belongs to the saline substances of the neutral kind, as appears by its constituent parts. When burnt, generates heat with water, but in a less degree than lime does: (as was observed in *note n* to *page* 32). *Berg. Seag.* § 59.

This salt has a particular taste, neither bitter nor astringent, but earthy, when applied to the tongue: and it is owing to it that some waters, chiefly from pumps and wells, are called *hard waters*, because they lay heavy on the stomach.

It is inalterable whilst kept in a dry place: but on being exposed to a moist air, it is much alter'd, and suffers a kind of decomposition.

When exposed to fire, so as to lose the water off its crystallization, it assumes a dead white colour. It is what we call
plaster

S E C T. 190. (Additional.)

Nitre of Lime. Terrene nitre. *Calx nitrata*, lat.
Nitre Calcaire of Mr. Morveau.

This earthy salt is sometimes found in water, but very sparingly. It is said that the chalk

plaster of Paris (see note *n* to Sect. 13.) : but if the fire is too strong, it melts and vitrifies, after losing the vitriolic acid with which it is saturated.

If put over a very hot iron, it becomes phosphoric.

It is decomposed by fixed alkalis, which have a stronger attraction to its calcareous base. *Mongez*.

According to Kirwan, its solution mixes uniformly with the nitrous and marine felenite (Sect. 190 and 191) ; but is precipitable by fixed alkalis, mild or caustic : and also by the saccharine acid, but not by the volatile caustic alkali, which distinguishes it from the Epsom salt of Sect. 196 ; and from *Alum* of Sect. 200, and following.

The most famous quarries of Gypsum in Europe, are those of Montmartre near Paris. See *Journal de Physique* for 1780, tom. 16. p. 289, and for 1782, vol. 19. p. 173.

It is found also in the vegetable kingdom. Mr. Model found that the white spots in the root of Rhubarb, are a felenitical or gypseous earth (*Journal de Phys.* vol. VI. p. 14.)

What is called *fossil flour* (*farine fossile* in French) generally found in the fissures of rock and gypseous mountains, is very different from the *agaricus mineralis* of Sect. 5. and from the *lac lunæ* of Sect. 130 : as it is a true gypseous earth already described in Sect. 14. which, according to Mongez, is of a white and shining colour : though sometimes it assumes a reddish or blueish colour, on account of some martial mixture.

See in Sect. 13. and following, other varieties and properties of the gypseous earth.

hills

hills in some parts of France, become spontaneously impregnated with nitrous acid, which may be washed out, and after a certain time they will become impregnated with it again, *Berg. Sciagr.*

It is a combination of the nitrous acid with calcareous earth.

1. Is deliquescent, and is soluble in twice its weight of cold water, or in an equal weight of boiling water.
2. Its taste is bitter.
3. Is decomposed by fixed alkalies, which form the cubic, or the prismatic nitres of Sect. 178 and 174.
4. But caustic volatile alkali cannot decompose it.
5. It does not deflagrate in the fire; yet paper moistened with a saturated solution of it, crackles in burning.
6. In a strong red heat, it loses its acid.
7. Its solution does not trouble that of silver in nitrous acid.
8. The vitriolic acid precipitates its basis.
9. As does likewise the acid of fugar.
10. One hundred parts of it contain, when well dried, about 33 of nitrous acid, 32 of calcareous earth, and 35 of water.

It exists in old mortar, and in the *mother liquor* of nitre; and also in the chalk rocks near *Roche Guyon*, in France. *Kirwan.*

This salt is found for the most part of a reddish colour; and Wallerius says, that it has been found on the walls of a fortress at Upsal. *Editor.*

S E C T. 191. (128.)

Muriatic chalk, or fixed salt ammoniac. *Acidum salis communis terræ calcarea saturatum*, lat. *Muriate calcaire de Morveau*. French.

This somewhat deliquesces, or attracts the humidity of the air: It is found in the sea-water. See Sect. 21. [a].

S E C T.

[a] It is with great impropriety that this salt has obtained the name of *ammoniac*, on account only of its being formed in the chemical laboratories, during the decomposition of the ammoniacal salt with lime, in the process for making the caustic volatile alkali. In this case, the Muriatic acid unites to the calcareous basis, while this last gives its water to the volatile alkali, which therefore comes over in a fluid caustic state; but if chalk is employed instead of lime, the volatile alkali receives the aerial acid instead of water, and comes over in a concrete form; in neither case, the new combination of calcareous earth with muriatic salt has any volatil alkali, to deserve the name of *ammoniacal salt*. *Macquer*.

1. This earthy salt has a saline and very disagreeable bitter taste. It is supposed to be the cause of that bitterness and nauseous taste of sea-water,
2. It fuses in the fire, and becomes phosphorescent, after undergoing a strong heat.
3. It becomes hard, so as to strike fire with steel:
4. It is then the phosphorus of Homberg:
5. It is decomposable by ponderous earth, and fixed alkalis.
6. And also by the vitriolic or nitrous acid, which expel the muriatic acid, to unite with the calcareous basis. *Mongez*.
7. Its solution renders that of silver in the *nitrous acid* turbid, at the same time that

S. It

S E C T. 192. (Additional.)

Aerated chalk, *Calx aerata*.

Whenever calcareous earth is over saturated with the *aerial acid*, it becomes a true earthy neutral salt: becomes soluble in water: and has a slight pungent bitter taste. It is commonly found dissolved in waters in consequence of an excess of the aerial acid. When this greatly abounds, the water is said to be hard (*cruda*). By boiling or by evaporation, it deposits streaks or crusts of calcareous matter.

But when the calcareous earth is only saturated with the aerial acid, without excess, it is not easily soluble; it is then the calcareous spar of Sect. 10. and is properly referred to the class of earths. See the 4th and following Sections.

-
8. It makes no change in that of nitrous selenite.
 9. It obstinately retains its acid in a red heat.
 10. One hundred parts of this earthy salt contain, when well dried, about 42 of marine acid, 38 of calcareous earth, and 20 of water.
 11. It is found in mineral waters, and in the salt works at Saltzburg. *Kirwan*.

S E C T. 193. (Additional.)

Vitriolated ponderous earth. *Terra ponderosa vitriolata. Barytes vitriolata.*

This earthy salt, known by the name of *ponderous spar*, is a combination of the ponderous earth described in Sect. 48. with the vitriolic acid; and has been already treated of in Sect. 50.

N. B. The nitrous ponderous earth, according to Bergman, has not yet been found, although it may perhaps exist somewhere; and of course be discovered in Nature.

S E C T. 194. (Additional.)

Muriatic Barytes. Marine Baro-selenite. *Barytes Salita.*

This earthy salt consists of marine acid united to the ponderous earth. It is said to have been found in some mineral waters in Sweden: and may be known by its easy precipitability with vitriolic acid; and by the great insolubility and weight of this resulting compound, which is the true ponderous spar of the preceding Section.

S E C T.

S E C T. 194. (Additional)

Aerated ponderous earth. *Barytes aerata.*

This earthy neutral salt was found lately by Doctor Withering, in a mine at Alstonmore in the county of Cumberland in England, as has been noticed in Sect. 49. where may be seen a short account of its properties. The Doctor says that it is very pure, and in a large mass. This substance is a new acquisition to mineralogy, and may be turned to useful purposes in chemistry. He gave an account of it to the Royal Society of London, which was inserted in the Philosophical Transactions for 1784, part 2. page 293.

1. It effervesces with acids, and melts with the blow pipe, though not very readily.
2. In a melting furnace, it gave some signs of fusion; but did not feel caustic when applied to the tongue, nor had it lost its property of effervescing with acids.
3. But the precipitated earth from a saturated solution of it in the marine acid, by the mild vegetable or mineral alkali being burned, and thrown into water, gave it the properties of lime water, having an acrid taste in a high degree: and a single drop of it added to the solutions of vitriolated

lated salts, as the *Glauber salt*, *vitriolated tartar*, *vitriolic ammoniac*, *alum*, *Epsom salt*, *selenite*, occasioned immediately a precipitation; from whence it appears to be the *nicest test to discover the vitriolic acid*. By it the marine acid may also be easily freed from any mixture of vitriolic acid, by means of this calx of ponderous earth.

Consult the said paper of Dr. Withering, inserted in that volume of the *Philosophical Transactions*, for a variety of ingenious observations on ponderous earth, and its different combinations, &c.

S E C T. 195.

Vitriolated magnesia. *Magnesia Vitriolata*.

This earthy neutral salt is called by the English *Epsom salt*. *Sel d'Angleterre* by the French; and also *sel de Sedlitz*, *de Seydschütz*, *sel amer*, *sel cathartique amer*; &c.

These various names are given to it; either on account of its properties, it being a very mild purgative; or from the places where it is found, besides many others as in the waters of *Egra*, of *Creutzbourg*, *Obernental*, *Umea*, &c. It has also been found native, mixed with common salt, and coally matter, germinating on some free stones in coal mines. See *Kirwan's Mineralogy*, p. 183.

1. It has a very bitter taste.
2. It is soluble in one part and a half of its weight of cold water: but in hot water, a given weight of it dissolves the double of this salt.
3. It effloresces when exposed to a dry atmosphere, and is reduced to a white powder.
4. Exposed to the fire it loses the water of its crystallization, and is reduced into a friable mass.
5. This earthy salt is decomposed by fixed and volatil alkalies.
6. Lime-water precipitates the magnesia from its solution, the calcareous earth of lime-water combining itself with the vitriolic acid, and forming a selenite. N. B. By this test the vitriolated magnesia is easily distinguished from the vitriolated mineral alkali, or *Glauber's salt* which it resembles.
7. But crude chalk, or aerated calcareous earth, has not such an effect in the same case: which shews how much the efficacy of this substance, viz. the calcareous earth, is diminished merely by its union with the *aerial acid*.
8. When urged by the flame with the blow-pipe, it froths; and may be melted by being repeatedly urged with that instrument.
10. With borax it effervesces, and also when burned with the microcosmic salt.

11. According to Bergman, one hundred weight of this salt contains only nineteen parts of pure magnesia, thirty-three of vitriolic acid: and forty-eight of water. But
12. According to Kirwan, one hundred parts of it contain about twenty-four of real vitriolic acid, nineteen of magnesian earth, and fifty-seven of water.

S E C T. 197. (Additional.)

Nitrated Magnesia. Nitrous Epfom Salt. *Magnesia nitrata.*

This earthy salt is usually found together with nitre. It is a combination of the nitrous acid with the magnesian earth.

1. It has an acrid taste, very bitter.
2. Attracts the moisture from the atmosphere, and deliquesces.
3. Is very soluble in water.
4. Is easily decomposable by fire.
5. The ponderous and calcareous earths decompose it, and also the alkalies.
6. On being urged by the blow-pipe, it swells up with some noise, but does not detonate.
7. If saturated solutions of nitrous selenite and of this salt be mixed, a precipitate will appear, but

8. Neither

8. Neither vitriolic acid, nor mild magnesia will occasion any turbidness in its solution.
9. One hundred parts of this salt contain about thirty-six of real nitrous acid, twenty-seven of magnesian earth, and thirty-seven of water.

It exists in old mortar, and is found also in the mother liquor of nitre. As lime-water decomposes it, Mr. de Morveau has indicated the use of this process, not only to complete its analysis; but also to separate, in large quantities, and at a very cheap rate, the magnesian from the calcareous earth, as Mr. Mongez relates upon this subject.

S E C T. 198. (Additional.)

Muriatic Magnesia. *Magnesia Salita.*

This earthy salt is a combination of magnesian earth with the muriatic acid. According to Bergman, it is found in the sea in greater plenty than any other salt, except the sea salt.

1. It has a very bitter taste: and being always mixed in the sea-water, it is the principal cause of its bitterness.
2. It is very deliquescent, and soluble in a small quantity of water.
3. All the alkalies, even the caustic volatile alkali, and lime, decompose it by precipitating its basis.

C c 2

4. The

4. The vitriolic, nitrous, and boracic acids expel the muriatic acid from the base of this neutral salt.
5. Its solution does not trouble that of *nitrous* or *marine selenite*: but
6. It causes a cloud in the nitrous solution of silver.
7. The vitriolic acid throws down no visible precipitate from the solution of this neutral Salt.
8. It loses its acid in a red heat.

S E C T. 199. (Additional.)

Aerated Magnesia. *Magnesia aerata.*

Common magnesia with an excess of aerial acid is a true neutral salt, like the aerated selenite of Sect. 192: and becomes soluble in cold water. Otherwise it is scarce soluble at all; and is then classed among the earths. See Sect. 53 and following.

This neutral salt is decomposable by fire, by which its water and its acid are expelled: and it may become phosphoric.

When urged by fire, it agglutinates a little: and some pretended, that it melts. But by what appears in Note i to page 94, it must be in an impure state to vitrify at all.

The three mineral acids, and the alkalis dissolve this salt with effervescence, by expelling the aerial acid.

SECT.

S E C T. 200. (124.)

Argillaceous earth combined with vitriolic acid. The Alum Kind. *Alumina* [a].

a. With a small quantity of clay, *Acidum vitrioli argillâ saturatum*. Native or plumose alum, *Alumen nativum sive plumosum*.

Is

[a] This salt is sometimes spontaneously generated, by the decomposition of pyrites lodged in argillaceous schistus, and clay.

It is found in a spring at Steckenitz in Bohemia, and elsewhere. *Bergman*.

Mr Kirwan affirms on very good authorities that this salt is found native in a few mineral springs, though rarely; in the mineral lakes of *Tuscany*; also germinating on the surface of free stone or schistus in coal mines, or in Lavas near Volcanos; on several rocks in the *Archipelago*; on various parts of *Hungary*, in the *East*, *Bohemia*, and *Switzerland*, though seldom pure. Native alum mixed with vitriolic ammoniac, is found crystallized on the borders of the mineral lakes of *Tuscany*; and also in a capillary form near the lake of *St. Agnano*, and in the grotto of *St. Germano*.

1. According to Kirwan, alum requires about 15 times its weight of water, to be dissolved in the temperature of 60 degrees of Fahrenheit. But Beaumé, quoted by Mongez, says that it requires 18 times its weight of cold water, viz. that two *pints*, or *livres* of cold water are required to melt 14 *grs*: from whence it appears, the necessity of expressing the degree of the thermometer in which such experiments are made, to form a proper idea of them, a circumstance which Mr. Kirwan is in general very careful of pointing out. The same Mr. Beaumé adds, that boiling water dissolves more than half its

C c 3

weight

Is found on decayed alum ores in very small quantities; and therefore, through ignorance, the *alabastrites* and *selenites*, both

weight of alum: but Professor Bergman says, that 100 parts of crystallized alum require, in a mean heat, 1412 of distilled water to be dissolved: and that of boiling water, only 75 are sufficient.

2. Its specific weight, according to Bergman, is = 2071; but if the aerial acid contained in it is included in the computation, it is but = 1757.
3. Its flavour is sweetish, and remarkably astringent.
4. It swells and blisters when heated on the fire, and leaves a light-spongy substance of a dead white colour. In this state is called *calcined alum*; loses half its weight; and having lost the water of crystallization, the vitriolic acid remains more concentrated, the taste becomes more acrid, and exerts its corrosive properties in a higher degree.
5. It is precipitable by all *alkalis*, and even by *magnesia*, which distinguishes its basis from that of Epsom-salt (of Sect. 196) the argillaceous earth being abandoned by the vitriolic acid, and this last uniting to the magnesian earth, from whence it evidently appears, how groundless opinion of those is, who asserted these two earths to be identic. The precipitated argil retains still nearly half its weight of the vitriolic acid to which it was united; and is in reality an *embryon alum*. But by digesting it in volatil alkali (because its basis would unite to fixed alkalies) it may be properly purified.
6. Its solution, like that of Epsom-salt (of Sect. 196), renders the nitrous solutions either of silver, or chalk, turbid; but mixes uniformly with those of *nitrous* or *marine alum* (of the following Sect. 202); or of the vitriols of any metal. These properties distinguish it sufficiently, as Mr. Kirwan expresses himself.
7. According to the same author, one hundred parts of alum contain about 24 of vitriolic acid; 18 of argillaceous earth, and 58 of water.

of

of which are found among most of the alum flates, are often substituted in its stead; as is also sometimes the *asbestos*, notwithstanding the great difference there is between the alum and these, both in regard to their uses and effects [b].

b. With a greater quantity of pure clay, *Argilla pura acido vitrioli imbuta*. White alum ore, *Minera aluminis alba*.

1. Indurated pale-red alum ore, *Schistus aluminis Romanus*. Is employed at *Lumini*, not far from *Civita Vecchia* in Italy, to make the pale-red alum called *Roch Alum* [c]. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it, does not shew the least marks of any metallic substance [d].

c. With

[b] The gypsa and asbesti, but more especially the latter, have been used through ignorance, in most countries, for plumose native alum; and the sort sold formerly in the shops for it, was a greenish-white kind, from Germany, very rigid, but extremely brittle, and breaking into spicula or prickles, D. C.

[c] This neutral salt is called sometimes *Roch alum*, from an ancient city in Syria, called *Roccho*, and now *Edessa*, where the most early alum-manufacture was carried on; but this name has been changed, through ignorance, into *rock-alum*, as if it were naturely found in large masses like *stony rocks*. *Bergman de confect. aluminis*.

[d] What is called *Roman alum*, has been considered as the best sort; it has a rosy-coloured cast. It is manufactured at *Tolfa* near *Civita Vecchia*, and contains about *five per centum*

- c. With a very large quantity of martial clay, which likewise contains an inflammable substance, *Argilla martialis et phlogistica acido vitrioli imbuta*. Common alum ore.
-

of a rose-coloured earth, whose nature Professor Bergman did not ascertain, *but, says he, we know for certain, that the goodness of the alum does not depend upon it.* Mr. de Morveau suspects this colour to proceed from some slight mixture of iron. That from the manufacture of Brunswick has the same colour, which seems to proceed from the mixture of Cobalt, which it has been discovered to contain, both by Professor Bergman and Mr. Erxleben; but it seems to have some different properties from the Roman alum; and on my inquiring from Mr. Waugh, a capital Salter-druggist in London, whether the rosy-coloured alum called Roman, was preferred by our manufacturers to the white alum, he answered in the negative. Mr. Gustav Von Engestrom, counsellor at the Board of Mines in Stockholm, to whom I am indebted for my attachment to mineralogical subjects, since I had the happiness of his acquaintance when he visited this country about twenty years ago, wrote to me in 1783, that he has discovered an easy and infallible method for purifying alum from the smallest mixture of iron, which is a desideratum in the dying business, and very worthy of the attention of our manufacturers. The same gentleman has also discovered a method of purifying salt-petre from any mixture of marine salt, which is a great acquisition for the manufacture of gun-powder: he has besides sent me a specimen of canvass so prepared, that it cannot take fire, a circumstance which might be of great advantage to prevent the decorations, in the play-houses and other public places, from taking fire. He was then about to publish a chemical work, the first part of which treats of the refining of gold and silver; but it being in the Swedish language, I must wait, with most English readers, for its translation into a more common idiom, to profit by the great knowledge and skill of this most able chemist. *The Editor.*

Is commonly indurated and flaty, and is therefore generally called Alum-Slate, *Schistus aluminosus ater et brunescens*.

It is found,

1. With parallel plates, having a dull surface, *Schistus lamellosus tegularis*, from Andrarum in the province of Skone, Hunneberg and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c. [e].
2. Undulated and wedge-like, with a shining surface, *Schistus aluminosus undulatus et cuneiformis fissuris splendentibus*.

This at the first sight resembles pit-coal; it is found in great abundance in the parish of Nas in Jemtland.

[e] In England, the great alum works at Whitby, in Yorkshire, are of this kind. D. C.

S E C T. 201. From the Author's Note to the preceding Section.

Observations on Alums.

The purity abovementioned in the last Section *b. 1.* of the earth of the Roman or Roch alum, is meant with the same restriction as in general is understood by that expression: viz. that the heterogeneous particles are not very obvious, nor of any great consequence [*a*].

The

[*a*] Besides the numerous uses of this neutral salt in the *materia medica*, it is very advantageously employed in various æconomical uses. When added to tallow, the candles made therewith are harder (see this process at large in *Bibliothèque Physico-æconomique* for 1782 at the word *Bougies æconomiques*). Wood sufficiently soaked in alum, does not easily take fire; the same is true of paper impregnated with it, which is fitter to keep gun-powder, as it also excludes moisture. Paper impregnated with alum, is useful in whitening Silver, and sil-vering brass without heat. Alum mixed in milk, helps the separation of its butter. If added in a very small quantity to turbid water, in a few minutes it renders it perfectly limpid, without any bad taste or quality: whilst the vitriolic acid does not precipitate so soon, nor so well, the opaque earthy mixtures that render it turbid, and gives to it a very sensible acidity as I have often tried. It is used in making the pyrophorus, in tanning, and many other manufactories, particularly in the art of dying, in which it is of the greatest and most important use, by cleansing and opening the pores on the surface of the substance to be dyed, rendering it fit for receiving

The phlogiston which is contained in the black alum slates, may perhaps during the calcination dispose the iron to be more easily dissolved; and it may also occasion the black colour in some of them, that even contain but very little

receiving the colouring particles (by which the alum is generally decomposed), and at the same time making the colour fixed. Alum constitutes the basis of crayons, which generally consist of the earth of alum, finely powdered and tinged for the purpose. It is also employed in the preparation of Prussian blue, &c. *The Editor chiefly from Bergman.*

The greater part of this salt is factitious, being extracted from various ores, such as

1. The *sulphurated clay*. This constitutes the purest of all aluminous ores, namely that of *la Tolfa* near *Civita Vecchia* in Italy. It is white, compact, and as hard as indurated clay; from whence it is called *petra aluminaris*. It is tasteless and mealy: one hundred parts of this ore contains above forty of *sulphur*, and fifty of clay, a small quantity of fixed vegetable alkali, and a little iron. Bergman says it contains forty-three of *sulphur* in one hundred, thirty-five of *argill*, and twenty-two of *siliceous earth*. This ore is first torrefied to decompose the *sulphur*, whose vitriolic acid reacts on the *argill*, and forms the alum.
2. The *pyritaceous clay*, which is found at *Schwemsal* in *Saxony*, at the depth of ten or twelve feet. It is a black, and hard, but brittle substance, consisting of clay, pyrites and bitumen. It is exposed to the air for two years; by which means the pyrites are decomposed, and the alum is formed. The alum ores of *Hesse* and *Liege* are of this kind: but they are first torrefied, which, according to my late worthy friend Mr. Jars, is a disadvantageous method.
3. The *shistus aluminaris*. This differs from that of Sect. 146, as it contains a variable proportion of *petrol* and *pyrites* intimately mixed with it. When these last are in a very large quantity, this ore is rejected as containing

little of iron, as most likely in part of those from Nas mentioned Sect. 200. c. 2.

.....

 Aluminous fossil-woods are actually employed for making alum in Bohemia and Hesse. These earths may, or may not, contain iron; however, they prevent, in the former case, the phlogiston, together with the vitriolic acid, from mineralizing all the iron, and making a marcasite of it, excepting here and there, in some insignificant quantity, as in cracks, or when it meets with some heterogeneous bodies, as shells, insects, &c. in the said earths. There is a remarkable progression from the black alum

ing too much iron. Professor Bergman very properly suggested, that by adding a proportion of clay, this ore may turn advantageously for producing alum. But if the *petrol* is considerable, it must be torrefied. The mine of *Becket* in *Normandy*, and those of *Whitby* in *Yorkshire*, are of this species.

4. *Volcanic aluminous ore.* Such is that of *Solfaterra* near *Naples*. It is in the form of a white saline earth, after it has effloresced in the air; or else it is in a stony form.
5. *Bituminous alum ore.* Is called *shale*, and is in the form of a sluitus, impregnated with so much oily matter or bitumen, as to be inflammable. Is found in Sweden, and also in the coal mines at *Whitehaven*, and elsewhere.
6. Alum might also be extracted from many species of pyrites, but so contaminated with iron, as scarce to pay the expences of the operation. It may be also extracted from calamine, and pyritaceous fossil woods: which last are employed in some aluminous works at Bohemia and Hesse, as the noble author asserts. *Editor chiefly from Kirwan.*

flates

flates to the pit-coal, in proportion as the quantity of the phlogiston encreases, and the quantity of the earth decreases (such as will be mentioned in Sect. 159 of the Author). It is the phlogiston which makes this alum slate capable of burning by itself, when it is once lighted; wherein it differs from the alum ores of Lumin, which, in order to be brought to moulder, require the being exposed to the heat of the sun, and to be sprinkled with water: the former has also within itself sufficient matter to flame spontaneously upon certain occasions, according to what the celebrated experiments of Lemery, and others, demonstrate, and from which cause many volcanos and earthquakes may perhaps be deduced. The *pulvis pyrophorus* is also made of alum [b], intimately united with a phlogistic substance; in the preparing of which, they ought carefully to avoid that

[b] Bergman seems to affirm that alum, unless it has some mixture of vegetable alkali, as the Roman alum has, is not fit for making the pyrophorus: but Morveau thinks that no alkali is required for its production, and quotes various residuums which are true pyrophori without containing any alum at all, as may be seen in the memoir of Proust inserted in the supplement of the *Journal de Physique* for 1778, p. 42. Almost every substance which leaves, after its decomposition, a coaly matter, simply divided by an earth, or a metallic calx, possesses the same pyrophoric property. See the last paper of my late worthy friend Mr. Bewly, inserted in the fourth volume of Dr. Priestley's work on *different kinds of air*, page 485, where he speaks of Mr. Proust's first observations on this subject of pyrophori. *The Editor.*

any

any iron enters the mixture, because the acid has too strong an attraction to the iron, and cannot unite with the phlogiston alone, which, however, is quite necessary in this operation. *The Author.*

S E C T. 202. (Additional.)

Argillaceous earth saturated with muriatic acid.
Argilla Salita.

Professor Bergman says that the combinations of the argillaceous earth with the *nitrous*, *muriatic* and *aerial* acids had not yet been found naturally formed as far as he knew. But Doctor Withering affirms that he found the *muriatic argill* to exist in a considerable quantity, in the *Nevil Holt water*, when he analysed that mineral water about the year 1777: and he adds that it is probably contained also in the *Ballycastle water* in Ireland. See the Note of the Doctor to Sect. 67. of his translation of Bergman's *Sciagraphia*.

S E C T. 203. (142.)

Argillaceous earth mixed with volatil alkali.

Alcali minerale volatile argillâ mixtum.

Although this mixture is by no means a neutral salt, this seems to be the place to treat of it according to the order of saline substances adopted in this edition [a].

The greatest part of the clays contain a volatile alkali, which discovers itself in the distillation of the spirit of sea-salt, &c. [b].

O R D E R

[a] It was out of respect for the Author, that I keep this section separate by itself, though the essential part of the contents have been inserted in its proper place, viz. in Sect. 171, Note a. In fact it does not appear, that there is any real combination, or saturation of the volatil alkali with the argillaceous earth, resembling that of the same alkali with the marine acid, which constitutes the ammoniacal salt of Sect. 186 among the neutral salts: but a simple mixture, without the combination required to produce a third substance, with peculiar properties to itself. But having ranged the earthy neutral salts, according to their bases by the order they are put in the preceding Sections; I apprehend that this Section, if inserted at all, ought to be in this place. *Editor.*

[b] Supposing some of the clays to be produced from the mould or *humus ater* (Sect. 153.) it is not difficult to see the reason of the presence of this alkali in them; but, though it would be both useful and curious to know all the changes of minerals, yet it is much better to take and employ them in their

ORDER THE FIFTH.

Metallic Salts. *Salēs mediū Metallici.*

SECT. 204. (Additional).

The native salts belonging to this division, may be distinguished by the *phlogisticated alkali*, which precipitates them all. The few which have saline properties, according to the definition of salts already given (page 10 and note g.) shall be mentioned here, referring the rest to the mineralised metals, as the *horn-silver* (*Luna*

their present state, than to lead the mind into perplexities by examining the combinations of these things by other means than by what the external senses shew, and by rational experiments.

A German author has lately asserted, that metals, according to his experiments, have been found dissolved or mineralised by a volatile alkali; but, besides that some subjects mentioned by him; for instance, the *Sinople*, or Red Chalk; the *Hungarian Gilben*, or Vein Stones; and the *Horn Silver ore*; do not shew the least mark of it; there is also wanted a description of the experiments he has made, and of the phenomena which have presented themselves to him, during the examination of the other ores which he has mentioned: for these reasons his opinion cannot yet be admitted. *The Author.*

Cornea,

Cornea, or *Argentum Salitum*) mentioned by the noble Author in his Sect. 134; the saline quicksilver or muriatic mercury &c. *Bergman's Sciagraphia*:

S E C T. 205. (122. 2.)

Vitriol of Copper. Blue Vitriol. *Vitriolum Veneris*, seu *Cyprium*. *Cupprum Vitriolatum* [a].

This is of a deep blue colour: and is found in all *Ziment waters*, as they are called; for instance, at Neusohl in Hungary, in St. Johan's mine

[a] This neutral metallic salt is a combination of the vitriolic acid with copper.

1. Its colour is blue: and, being long exposed to the air, it degenerates into a rusty yellow blue.
2. Requires *four times* its weight of water, to be dissolved in the temperature of *sixty* degrees of Fahrenheit.
3. Its specific gravity is about 2230.
4. One *hundred* parts of this salt contain thirty of vitriolic acid: twenty-seven of copper: and forty-three of water.
5. *Eighty* parts of iron precipitate one *hundred* of copper from a solution of this salt, if it does not contain a notable excess of acid: *Kirwan*.
6. This salt has a harsh, stiptic, metallic taste.
7. If rubbed on a wet knife; or polished plate of iron, or if such a body be dipped into a solution of this salt, it will almost immediately be covered with a copperous reddish coat; because the acid, by its stronger attraction to the iron, corrodes it, and leaves the copper behind.

mine at Fahlun in the province of Dalarne, at Nya Kopparberget in Westmanland, and the copper-mines at Wicklow in Ireland, &c. It is however seldom perfectly free from an admixture of iron and zink.

8. Fixed alkalies precipitate the copper from a solution of this salt, in the form of a blue powder, which on drying becomes greenish; but
9. The precipitation by the volatile alkali, is at first of a whitish blue, and afterwards takes a fine deep blue colour. This together with the quality of N^o. 7. discovers its basis: as its uniform mixture with other vitriolic salts does its acid. In general the blue colour produced by the volatile alkali is a characteristic of the presence of copper in any solution.
10. It melts easily on the fire: loses its water of crystallization; is reduced to a whitish blue powder: and is at length almost entirely decomposed in a violent fire, the acid being separated from its basis.
11. Urged by the flame of the blow-pipe on a piece of charcoal, it froths at first with noise, giving a green flame, and the metallic particles are often reduced to a shining globule of copper, leaving an irregularly figured scoria. But with borax, the scoria is dissolved, and forms a green glass.

This salt rarely occurs crystallized: but is often found naturally dissolved in water, in *Hungary*, *Sweden*, and *Ireland*: from this water a blue vitriol is generally prepared. These natural waters are called *cementatory* or *cementing* ones. According to *Monet*, this concrete salt when found naturally formed, only proceeds from the evaporation of such waters.

It is also occasionally extracted from sulphurated copper ores, after torrefaction. *The Editor chiefly from Kirwan and Mongez.*

S E C T. 206. (Additional.)

Muriatic Copper, or Marine Salt of Copper.
Cupprum Salitum.

This salt has been found in *Saxony*; in the mine of *Johngeorgensstadt*.

1. It is of a greenish colour, and foliated texture.
2. It is moderately hard.
3. Sometimes it is transparent, and crystallized.

It has been taken for a kind of mica: but Professor Bergman found it to consist of *Copper* and *marine acid*; with a little argillaceous earth.

Another specimen of a purer sort, was deposited in the Museum of Upsal. This is of a bluish green colour, and friable. It effervesced with nitrous acid, to which it gave a green colour: and, by adding a proper solution of silver, a *Luna Cornea* was formed, by which the presence of the muriatic acid was ascertained. *Editor from Kirwan and Bergman.*

S E C T. 207. (122. 1.)

Martial Vitriol. Vitriol of Iron. Common green Vitriol, or Coperas. *Vitriolum martis simplex.* *Ferrum Vitriolatum* [a].

This is the common green vitriol, which is naturally found dissolved in water, and is produced

[a] This metallic neutral salt results from the combination of the vitriolic acid (§ 127.) with iron.

1. It is of a greenish colour when perfectly and recently crystallized; but
2. Effloresces by being exposed to the air, becomes yellowish, and is covered with a kind of rust. Sometimes it becomes *white* by long standing (see the end of this note.)
3. It requires six times its weight of water, in the temperature of sixty degrees, to be dissolved.
4. Has an astringent harsh and acidulous taste.
5. Exposed to a moderate heat, even to that of the sunshine, it falls into an yellowish powder; but
6. On being exposed to a sudden heat, it melts: and on cooling, assumes a whitish brown colour.
7. When strongly urged by fire, it loses its acid, becomes of a dark red colour, and is then called *colcothar*, a powder which is employed in polishing metals; and to which our artists have applied the improper name of *crocus martis*, though this name only belongs to the *yellow* preparations of the iron-calces, used in pharmacy, and in enameling, &c.
8. Pure fixed alkali precipitates the iron from its solution, in deep green flakes: the mild alkali, in a greenish white colour:

duced in abundance by decayed or calcined mar-
casites.

S E C T.

colour: pure volatil alkali, in so deep a green that it appears black: but the mild volatil alkali precipitates it in a greyish-green colour.

9. All vegetable astringents, as the tincture of *stea*, *quina*, *gales*, &c. precipitate the iron in a black colour, from whence they are used as tests to discover its presence in chemical analyses: and it is from this black precipitate that the common writing-ink is made, being diluted in water, and there suspended by the Arabic or Senegal gums. Macquer advises to add eight ounces of *galls* coarsely powdered with three of green vitriol, and as much of *gum arabic*, in two pints of cold water, which is to be passed through a sieve, after twenty-four hours standing, for use. The proportions I have long employed, consist of eight ounces of *gales* broken into small pieces, with four ounces of green vitriol, equally divided into two pint bottles, or into a large one of leather, half filled with water, which I leave hanging behind the door of my study, to be shaken by its motion. From these I occasionally fill the ink-stand, adding to it two or three pinches of fine powdered gum-arabic; and putting in the bottle as much water as taken off, until the ink becomes so pale as to require a supply of fresh materials.
10. One hundred parts of this salt, recently crystallized, contain twenty of real vitriolic acid: twenty-five of iron: and fifty-five of water.
11. Its acid is known by this; viz. that its solution mixes without turbidity with the solutions of other salts, that contain vitriolic acid, as *Epsom*, *Selenite*, *vitriolated tartur*, &c.
12. And the basis of this metallic salt is known by the black colour, produced by the solution of vegetable astringents, as mentioned N^o 9.
13. On being urged by the flame thrown by the blow-pipe, it offers the same phenomena as the vitriol of copper, except that it does not colour the flame.

SECT. 208. (Additional.)

Aerated iron. *Ferrum aeratum.*

This metallic salt is a combination of the aerial acid (of Sect. 167.) with iron: and is found in

Green vitriol is frequently found native, either in coal mines, or in the cavities of pyritaceous mines, or adhering to their scaffolds in a stalactitical form. It is found also in small round stones, called *ink-stones*, of a white, red, grey, yellow, or black colour, which are almost soluble in water, and contain a portion of copper and zinc. Also sometimes in form of shistus or slaty pyritaceous stones. But the greatest part of that in use, is prepared by art, from the martial pyrites or mundic.

Martial pyrites is an iron ore, containing from one-sixth to one-third of *sulphur*, from one-eighth to five-eighth of *iron*: and the remainder consists of *argill* and *sillex*: the three first are intimately combined with each other, and the iron is in a semiphlogisticated state.

1. It strikes fire with steel, from whence it has its name.
2. It is generally of a *yellow* or *grey* colour.
3. Is of a globular or cubic shape, internally radiated: and sometimes is lamellar.
4. Commonly is partly soluble in *nitrous acid* with effervescence.
5. With *vitriolic acid* it dissolves slowly, and forms *allum*.
6. Detonates with nitre: and
7. Is very infusible.
8. Its specific gravity is from 3700 to 4912.

Some *pyrites* instead of *argillaceous*, contain *calcareous earth*. These are common in France, and their iron is in a dephlogisticated state.

Pyrites.

in the light-Chalibeate waters, where it is dissolved by an excess of this acid.

Pyrites are frequently found in a stalactical shape: and often form the matter of petrifications. They are also found mixed and interspersed through almost every sort of stones, except granits.

Those of a *filamentous* or striated texture contain least *sulphur*: those of a lamellar, most. These last effloresce difficultly, if at all: and are said to contain from twenty-five to thirty-five per cent of *sulphur*.

Vitriol is formed out of these stones, by *exposing* them a long time to the action of the air and moisture: or by *torrefaction* in open air, and subsequent exposition to its action, which operation in some cases must be often repeated, according to the proportion of their sulphur and the nature of their earth. The calcareous pyrites are those of which it is most easily formed, as they effloresce the soonest.

Good pyrites properly treated, yield about two-thirds of their weight of vitriol.

Vitriol is also prepared from mineral waters that hold copper in solution, which is precipitated by iron, this solution of the iron is afterwards crystallized, and always retains some copper.

In Hungary it is prepared from pyritaceous shistus; and in many places from a species of calamine. The vitriol of *Goslaar* commonly contains a portion of *zinc*; as that of *Hungary* and *Saxony* does of *copper*. The *English* and *French* vitriols are purer; yet sometimes contain a small portion of *alum*.

Turf and *peat* are sometimes impregnated with vitriol: other earths also often contain vitriol and alum. This vitriol is sometimes found of a *white colour*, on the borders of the mineral Lakes of *Tuscany*. Even the artificial English vitriol becomes sometimes *white* after a great length of time, as I found this very day in a paper bag of it in small pieces, among the materials for making ink, which I had forgotten above these six or eight years past on a shelf in my study. *The Editor chiefly from Kirwan.*

Mr. Lane, F. R. S. of London was the first that discovered in England the action of the aerial acid on iron, when the water is impregnated with that menstrum. The late Mr. Rouelle demonstrated the same phenomenon in France, upon this and other metals.

But the celebrated Professor Bergman seems to have preceded them both, nearly about the same time, though neither had any knowledge of each other's discoveries.

“ As far as I know (says Pr. Bergman in “ his Treatise on *Aerial acid*) fixed air alone, in “ its elastic state, does not dissolve, nor even “ corrodes any metal . . . but, when united with “ water, it attacks some of them.”

The great volatility of this acid is the cause, why this neutral salt is not often found. For the mere evaporation of the ferrugineous mineral waters, in order to analyze them, is sufficient to let loose the *aerial acid*: so that the iron which was there dissolved by its power, falls down to the bottom in the form of a light ore, which amounts to nearly $\frac{1}{1000}$ of the weight of the water: and, when fresh, retains so much phlogiston as to obey the magnet, as Bergman says.

“ Iron says the same Professor (*de Analyfi* “ *aquarum*), when barely saturated with aerial “ acid, refuses to unite with water; but may “ be taken up when this subtiler menstruum is “ superabundant in water. This superabund- “ ance adheres but slightly, and therefore flies “ off during evaporation . . . a pellicle is found “ entire.

“entire (on the evaporating water), when
“formed by iron: and in this case is tinged
“with the different prismatic colours . . . (ac-
“cording) to the various degrees of tenuity, or
“various states of dephlogistication in the (me-
“tallic) particles.”

S E C T. 209. (Additional.)

Vitriol of Cobalt, vitriolated Cobalt. *Cobaltum
vitriolatum.*

This metallic salt results from the combination of the vitriolic acid with cobalt.

3. It is of a rosy colour, when artificially made:
4. Effloresces when exposed to the action of the atmosphere: and
5. Takes then a greenish colour mixed with a pale purple, or a *Lilas colour* as the French call it.
1. When found native, it is always in an efflorescent state, from whence it arises that, in this case,
2. Its colour is greenish, mixed with a grey tint: but
6. It is difficultly soluble in water, and
7. Its solution is of a red colour.

8. The

8. The phlogisticated alkali precipitates the cobalt from the solution of this salt, which with borax gives an azure glass.

By the above qualities, chiefly the rosy-colour of the solution of this neutral salt, its basis is sufficiently distinguished. As to its acid, it is easily known by the same tests, as those of the preceding vitriols.

It is said to be found native in small pieces, mixed with a greenish efflorescence in cobalt mines. *Editor from Kirvan and Mongez.*

N. B. *Halotrichium*, *Trichites* or native alum, mixed with vitriol of cobalt will be treated of in Sect. 221.

S E C T. 210. (122. 3.)

Vitriol of Zink, Vitriolated Zink. White
 Vitriol. *Zincum Vitriolatum. Vitriolum
 Zinci* [a].

Is white and clear as alum; and is found
 at Rammelsberg in the Hartz, as also in the
 rubbish.

[a] This middle metallic salt results from the combination
 of vitriolic acid with zink.

1. Its colour is white.
2. Requires little more than twice its weight of water to dissolve it in the temperature of sixty degrees of Fahrenheit's thermometer; and deposits a greyish yellow powder.
3. Its specific gravity is 2000.
4. Its taste is very styptic.
5. It mixes uniformly with vitriolic neutral salts.
6. Precipitates nitrous or marine selenites from their solutions, by which its acid is ascertained.
7. It is precipitable in a whitish powder by alkalies, and earths: but
8. Neither iron, copper, nor zink precipitate it: by this circumstance its basis is sufficiently indicated.
9. If it contains any other metallic principle, this may be precipitated by adding more zink to the solution; excepting iron, which will of itself precipitate by exposure to the air, or boiling in an open vessel.
10. One hundred parts of this metallic salt contain twenty-two of vitriolic acid; twenty of zink, and fifty-eight of water.

11. Uiged

rubbish at Stollgrufvan in Westmanland, where the mock lead has decayed either spontaneously, or after having been burnt.

11. Urged by fire, it loses a good part of its acid.

12. Treated with the blow-pipe, it exhibits nearly the same phenomena, as other metallic vitriols: except only that the flame is brilliant when the zinc is reduced, and gives out white flocs, called *flowers of zinc*.

This neutral metallic salt is sometimes found native, mixed with vitriol of iron and in the form of white hairy crystals, or in a stalactitical form in the mines of *Hungary*, *Goslaar*: or as an efflorescence on ores of zinc.

It is also found dissolved in mineral waters, and generally with some proportion of vitriols of iron and copper.

Bergman says, that this salt is sometimes produced by the decomposition of *pseudogalena*, or *black jack*; but this rarely happens, because this substance does not readily decompose spontaneously. Sciag. § 73.

But that in common use is mostly prepared at Goslaar, from an ore, which contains *zinc*, *copper*, and *lead*, mineralized by *sulphur*, and a little iron. The copper is first separated as much as possible: the remainder after torrefaction and distillation, is thrown red-hot into water, and lixiviated. It is never free from iron. *Editor from Kirwan and Mongez*,

S E C T. 211. (Additional.)

Vitriolated Nickel, or Vitriol of Nickel. *Nic-
colum Vitriolatum.*

This is a middle or neutral metallic salt, which results from the combination of the vitriolic acid with Nickel. It exists sometimes, in consequence of the decomposition of the sulphureous ores of this semimetal. It is found native efflorescing on *Kupfer-nickel*: and generally mixed with vitriol of iron.

It is of a green colour, as well as its solution.

It is precipitated by zinc; but when joined with iron, this last is not precipitated by the same.

Its origin is perhaps owing to the decomposition of the pyritaceous and sulphurous ore of *Kupfer-nickel* mentioned by Wallerius, p. 190 of the second volume of his Mineralogy published in 1778. This ore contains a great quantity of arsenic and sulphur, as well as cobalt, nickel and iron. And if it comes to be decomposed in the bowels of the earth, it is natural to expect that the vitriolic acid of the *sulphur* will attack the nickel and the iron, with which it will form neutral metallic salts. *Editor from Mongez and Kirwan.*

S E C T.

S E C T. 212. (Additional.)

Muriatic Manganese. *Manganesium Salitum.*

Mr. Hielm is the only person who has as yet found this middle salt, in some mineral waters of *Sweden*. It is composed by the combination of the regulus of Manganese with muriatic acid.

1. It is precipitated of a whitish yellow colour, by the Prussian [phlogisticated] alkali: and of a brownish yellow, by the mineral alkali.
2. It does not crystallize, in any distinct form.
3. It abstracts the moisture of the air.
4. To obtain its basis free from iron, it must be precipitated by the mineral alkali: redissolved in nitrous acid; then calcined until this acid is expelled: and the residuum is to be treated with distilled vinegar, which will then take up only the manganese. *The Editor from Kirwan.*

S E C T.

S E C T. 213. (Additional.)

Observations on the metallic Salts of the preceding Sections.

It has been already observed Sect. 172. after Macquer, that this kind of salts are the least saturated of all neutral salts: and of course do not possess a perfect degree of neutralization.

Those already mentioned subsequent to Sect. 204. are the only ones that have been found formed by nature, and on this account they are entitled to enter into a system of Mineralogy.

But many other metallic combinations with some of the mineral salts, may be still discovered, which must be then added to those already known. Our very ingenious and profound chemist Mr. Kirwan has already pointed out various methods of distinguishing some of these salts which in all probability will be found, when mineralogical researches shall be pursued, with a due attention to the indispensable assistance of chemistry. The preparatory instructions as laid down by that eminent philosopher, may be seen in various parts of his truly valuable Elements of Mineralogy, to which the reader is referred, as a book which the editor of this work ardently recommends to all such as are desirous of acquiring a real knowledge of these useful processes.

The

The same philosopher affirms (page 194) that the vitriols of *copper*, *iron*, and *zinc*, are according to our noble Author, frequently found mixed in waters pumped out of mines: that some times all three are found crystallized in lumps of a yellow colour: and that Bergman affirms the vitriol of *Fahlun* in *Sweden* to contain all three. But these and other triple salts are to make the subject of the following Order.
The Editor.

ORDER

ORDER THE SIXTH.

S E C T. 214. (Additional.)

Triple Salts. *Saltes triplices.*

THE Neutral salts hitherto enumerated are such as are composed of two ingredients only; but sometimes three or more are so united as not to be separated by crystallization. The vitriols that we are acquainted with, are hardly ever pure; and two or three of them sometimes are joined together.

Sometimes likewise it happens that neutral salts join earthy salts, and earthy salts metallic ones. I generally distinguish compound salts according to the number of their principles, whether the same acid be joined to several bases, or the same base to different acids; or lastly, whether several menstrua and several bases are joined together. Hence arise salts triple, quadruple, &c. which the diligence of after-times must illustrate. I subjoin the most remarkable examples of triple and quadruple native-salts which have occurred to me. *Berg. Sciag.* § 75.

S E C T. 215. (137.) Aphronitrum.

Mineral Alkali with a small quantity of calcareous earth. *Alkali salis communis, terræ calcareæ parva portione combinatum.* Aphronitrum [a].

Whatever the noble Author says of the Aphronitrum in his Sect. 137, seems to belong with greater propriety to the calcareous nitre, combined with mineral alkali, which is in fact a triple salt, and of course belongs to this order, notwithstanding that the same has been classed among the alkalies in Sect. 170. [b]. His words are the following.

“ This

[a] The celebrated Wallerius in the second volume, page 46, of his Mineralogy, printed at Vienna in 1778, calls this salt by the name of *Aphronitrum*: and recites the experiments of Cartheuser, who asserts, that, on throwing into its solution in water, a fixed mineral alkali, the calcareous earth was precipitated: and on the contrary, that by the addition of oil of vitriol, a nitrous acid was expelled, and a *Glauber's salt* was produced; from which it is evident that the aphronitrum is a *triple salt* arising from the combination of the *nitrous acid* with *calcareous earth* and *mineral fixed alkali*. *The Editor.*

[b] The same Professor Wallerius in page 65 of that edition already quoted in the preceding Note a, speaks of three species of Aphronitrum, viz. one that contains only a mixture of *calcareous earth* with *fixed mineral alkali*: this he affirms to be the *aphronitrum* of the *antiens*: and adds in page 44, that it ought rather to be called *aphronatron*, which seems to be a very proper remark; since the same Antients gave the name

“ This is so strongly united with the calcareous earth, that the latter enters with it into the very crystals of the salt : though by repeated solutions the earth is by degrees separated from it, and falls to the bottom after every solution.

It grows in form of white frost on walls, and under vaults ; and in places, where it cannot be washed away by the rain [c].

When it contains any considerable quantity of the calcareous earth, its crystals become rhomboidal, a figure which the calcareous earth often assumes in shooting into crystals : but when it is purer, the crystals shoot into a prismatick figure.

name of *natron* to the mineral alkali, as was said in Note *a* to page 333.

The second *Aphronitrum* mentioned by Wallerius, is the *calcareous nitre* of Sect. 190.

And the third is that neutral salt described by Fr. Hoffman by the name of *Aphronitrum jenense*, into whose composition the vitriolic acid enters ; it is a kind of *Sal mirabile glauveri* : and is with great reason confounded with it, as is said in the text. *The Editor.*

[c] From these words of the Author it appears, that this is not only a *triple*, but a *multiple* salt ; as these pieces of old mortar covered with this white frost, on antient walls, are the very same from which the saltpetre-makers extract the *mother-water* of nitre, after mixing therewith the vegetable ashes, to furnish the alkaline base to it. Mr. Fourcroy says in his seventeenth Lecture that this mother-water contains not only nitre, but five other kinds of salt, viz. the *marine salt*, *nitrous-magnesia*, *calcareous-nitre*, *magnesia-nitrata*, and *calx-salita* : to which the Chymists of Dijon add the *digestive salt* of Sylvius, and in some cases various *vitriols* with *alkaline*, or *earthy bases*. See *Elemens de Chymie de l'Acad. de Dijon*, vol. II. p. 133. *The Editor.*

This is a circumstance which necessarily must confuse those who know the salts only by their figure; and shews, at the same time, how little certainty such external marks afford in a true distinction of things.

This salt is very often confounded with the *sal mirabile Glauberi*.

S E C T. 216. (Additional.)

Common salt with magnesia: or muriatic mineral alkali contaminated by muriatic magnesia. *Alkali minerale salitum, magnesia salita inquinatum.*

This is a compound of the common salt with muriatic magnesia: and by the expression *contaminated (inquinatum)* of professor Bergman, already explained in the Note to page 340, we may suppose that the magnesian salt is not intimately united to the alkaline base.

This triple salt is very deliquescent, a quality it owns to its integrant part the *muriatic magnesia* of Sect. 198. For the pure muriatic alkali does not deliquesce: but this degree of purity is seldom found; even in the native fossil or *sal gem* of Sect. 179. In general all the earthy marine salts are very deliquescent, as the *muriatic chalk* of Sect. 191; the *muriatic barytes* of Sect. 194; and the *muriatic magnesia* of Sect. 198. *Editor from Bergman, Macquer, and Mongez.*

S E C T.

S E C T. 217. (133.)

Mineral alkali with Succinous acid, and phlogiston. *Amber, Succinum.*

See this substance among the *Inflammables*, in Sect. 146 of the Author, viz. Sect. 234 of this edition.

S E C T. 218. (Additional.)

Vitriolated magnesia with vitriol of iron. Epsom salt contaminated with Copperas. *Magnesia Vitriolata, Vitriolo Martis inquinata.*

This triple salt is found in some mineral waters, according to Mr. Monet, in his Treatise on these waters. *Berg. Sciag.* § 77.

S E C T. 219. (Additional.)

Native-alum contaminated by Copperas. Vitriolated argil with vitriol of Iron. *Alumen nativum vitriolo martis coinquinatum.*

This triple salt is found in the aluminous shistus. It sometimes effloresces in a feathery form. Perhaps this is the *plumose alum* of the

anients. Cartheuser, in his *Elemens of Mineralogy* quoted by Wallerius, reckons the *plumose alum* among the martial vitriolic substances, and calls it *white martial native vitriol*, affirming that it is composed of longitudinal fibres or filaments, which are flexible and very close to one another. He observes,

1. That it has an acid styptic taste.
2. That its solution is turned into a black-purple, by that of galls.
3. And that, with the alkaline salts, the colour is of an obscure or deep green, which in both cases becomes afterwards yellow: and its transparency disappears, depositing a martial precipitate.

But as in Egypt, Macedonia, and Milo, is found a kind of native alum already mentioned (Sect. 200, p. 389), which consists of strait small filaments of a whitish colour, possessing the taste and other properties of the simple alum; there is no reason to confound this earthy salt, which Wallerius calls *Trichites of Dioscorides*, with the triple salt of this Section. See Wallerius's *Mineralogy*, vol. II. page 32 of the edition of 1778, and the following Sect. 221 concerning the *Trichites of Dioscorides*. The Editor from Berg. and Mongez.

S E C T. 220. (Additional.)

Native alum, contaminated by Sulphur. *Argilla vitriolata Sulphure inquinata.*

At the places about Wednesbury and Bilston, in Staffordshire, where the coal pits are on fire, this substance sublimes to the surface; and may be collected, in considerable quantity, during dry or frosty weather. I cannot be certain that this is a true chemical union, but the eye cannot distinguish the parts. Perhaps the sulphur volatilizes the alum: and so becomes intimately mixed with it. The excess of vitriolic acid keeps it in a deliquescent state.

I believe a similar compound substance sublimes at the Solfaterra near Naples. Dr. *Withering*.

S E C T. 221. (Additional.)

Native Alum contaminated by vitriolated Cobalt. *Alumen nativum vitriolo Cobalti inquinatum.*

In the mines of Herregrund and Idria this salt may be seen shooting out into long slender filaments. Perhaps this is the *trichites* of the Greeks.

1. Dissolved in water, it immediately betrays the presence of vitriolic acid, upon the ad-

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dition

dition of *terra ponderosa salita* (muriatic acid saturated with heavy earth.)

2. By the addition of phlogisticated alkali, a precipitate of cobalt is thrown down, which makes a blue glass with borax, or microcosmic salt. *Berg. Sciag.*

Mr. Mongez says that, according to Ferber, Scopoli, and the Baron de Dietrick, no traces of cobalt are found with the minerals of Idria: and that by the description of the *trichites* given by Dioscorides, it appears to be the same triple salt already described in Sect. 219. So that, according to Mongez, both the suspicion of Bergman in the present Section, and the opinion of Wallerius above-mentioned (in the same Sect. 219.) who calls the *plumose alum* of Sect. 200, by this name of *trichites*, most necessarily fall to the ground. *Editor.*

S E C T. 222. (123.)

Vitriol of copper with iron. *Vitriolum ferrum et cuprum continens. Vitriolum cupri martiali contaminatum* [a].

This triple salt is of a blueish green colour. Sometimes the *blue* predominates over the *green*: and sometimes this last over the *blue*. *Berg. Sciag. § 80.*

[a] This is the *vitriolum ferreo cupreum cyaneum* of Linnaeus. Its colour varies, being sometimes more or less green; and sometimes more or less blue. It is found at Saltzberg and at Falhun. This vitriol is called *vitriol of Hungary*, because it is found in the Hungarian mines, is of this kind. *Mongez.*

S E C T. 223. (123. 2.)

Vitriol of copper, iron, and zinc. *Vitriolum cuprum ferrum et zincum continens. Vitriolum cupri, et martiali et zincino inquinatum* [a].

This salt verges more to the blue, than to the green colour. It is made at Fahlun in Dalarne, from the water which is pumped out of the copper-mines: in this water large crystals of vitriol are often ready formed. If this vitriol is dipped in water, and afterwards rubbed on clean iron, the copper does not precipitate from it.

S E C T. 224. (123. 4.)

Vitriol of copper and zinc. *Vitriolum cupreo-zinceum.*

This is the blue vitriol from Goslar [b].

SECT.

[a] This quadruple salt is the *vitriolum ferreo-zinceo-Cupreum cyaneum* of Linnæus. Its colour is of a blue inclining to green. If rubbed on a polished surface of iron, the copper is not precipitated thereby, as it happens to the blue vitriol of Sect. 205; which shows that the vitriolic acid is perfectly saturated, in this salt, by the three metallic bases. *Mongez.*

[b] According to Mongez, this is the *vitriolum zinceo-Cupreum cæruleum* of Linnæus 105. 7. The same author (Mr. Mongez) makes a separate article of that compound salt, mentioned

S E C T. 225. (123. 3.)

Vitriol of iron and zinc. *Vitriolum zinco-ferreum*.

This is the green vitriol from Goslar in the Hartz [a].

tioned by Wallerius (Spec. 237. e.) which consists also of a vitriolated copper with zinc, but whose crystals are of a fine *red colour*, found lately, as Wallerius says, in the Fahlun mines: and adds, that the pale-blue colour of the first salt shows the predominancy of the copper, by which it is necessarily distinguished from the second, where the vitriol is over saturated (*sur composé*). I do not know whether a greater quantity of copper or of zinc, or of both, may furnish this salt with a *red colour*: but I should rather apprehend that it is owing to a proper quantity of iron in a *dephlogisticated state*, which has been overlooked in that compound. See what has been said of the colours of iron at page 81 of this volume.

Wallerius refers also to this same kind, another *yellowish* salt found in Hungary, which seems to be in the same circumstances as the preceding salt. *Editor*.

[a] According to Mongez, this is the *vitriolum zinco ferreum viride* of Linnæus 105. 6. Its colour is of a pale-green salt.

SECT.

S E C T. 226. (123. 5.)

Vitriol of Iron and Nickel. *Vitriolum ferrum
et niccolum continens.*

This salt is of a deep green colour, and is contained in the ochre, or decayed parts, of the Nickell, at the Cobalt-mines of Los, in the province of Helsingland [a].

[a] Most part of the vitriols owe their formation to art: because when such ores as contain sulphur, are worked by means of fire, the phlogiston of the sulphur is by the heat expelled, leaving the acid behind, which, being let loose or freed, is thereby enabled to attract and unite with watery vapours, dissolving at the same time the metals; and it is thus that the vitriols are formed. Every sort of ore does not commonly decay or wither in a natural manner, without being promoted by art; and this decaying or withering is mostly performed in the open air; for which reason no very great quantity of vitriol can be expected in that way: for when any ore thus withers or decays, the dissolved particles are by degrees carried off by the rain, and are at last found in a dissolved state in certain springs or mineral waters. All such ores may therefore be called true vitriol ores, as contain iron, copper, zinc, and nickel mineralised with sulphur. The acid in these vitriols, however, is not so perfectly neutralised by the metals, as it is by the alkali in the true neutral salts. *The Author.*

S E C T.

S E C T. 227. (143.)

Observations on Salts.

The perfect knowledge of these bodies must be had from chemical books and practical chemistry, as it constitutes the chief subject of that science [a]. From thence we likewise learn why the

[a] Chemists have given the character of *Saline* to those substances, which are more or less, (1) *sapid*; (2) *soluble* in water; and (3) *crystallizable*; (4) that possess the energy or power of *attraction* to combine with other bodies; and (5) that are *incombustible*.

The *three* first qualities flow naturally from the *fourth*: since the most *sapid* substances are those which have the greatest energy or power of *attraction* to combine with other bodies. When this power is of a higher degree, they are called *caustic* and also *corrosive*; because they act violently on our organs and other bodies, and destroy their texture, in a similar manner as fire does, when in contact with them.

But when salts become *saturated*, that is to say when they meet with a sufficient quantity of a proper matter to prevent the exertion of their great energy, they become *mild*. In general, these two epithets, *caustic* or *mild*, are applied to *alkaline* salts, when *deprived* of, or *saturated* with, *aerial acid*: and when their *corrosiveness* is lowered by being mixed with water, they are then said to be *diluted*.

In the same manner, when salts possess a less power of attraction, so as not to corrode the texture of other bodies, particularly of our own organs, they have accordingly a degree of *taste*, more or less remarkable to our senses: and of course are called *sapid*; whose varieties we distinguish by the words *sweet*, *sour*, *bitter*, *astringent*, and other terms expressive of the sensation they cause on our palate.

But

the acids are considered as salts, though a certain figure neither is found, nor can reasonably be expected in them. We are farther taught, that the angular figure, which is supposed to be

But when this quality is so feeble as not to be perceived at all, we call them *insipid* or tasteless; although by the phenomena of their combinations with other bodies, we are certain of their attractive power, or of their being really *saline*.

It is likewise owing to the power of attraction, that salts become *soluble* in water. Those, between which and water, a greater energy of this power subsists, are called *deliquescent*; because the watery particles, which are dispersed in the atmosphere, become attracted by them in preference to the aerial mass, in which the last were contained. But those salts which require the help of another force, such as that of gravity or heat, to bring them, to a nearer vicinity or contact between one another, so as to facilitate the exertion of their small attraction to the watery particles, are in fact *soluble*, but *not deliquescent*.

It is owing also to the power of attraction between the constituent parts of salts, that they *crystallize* under various and variable forms. This happens when the watery particles in which they are kept in solution, are successively reduced into vapour by virtue of their superior attraction to air, and to the surrounding bodies in contact with them. It is however required for this purpose that a certain flow process of time be allowed, in order that the saline particles may exert their *mutual attraction* according to their *polarity*, by which expressive word is to be understood that each saline particle is endued in one of its sides or ends, with a different degree of energy (or perhaps of repulsion) so that it rather unites, when at liberty, with one of the sides of another similar particle; so as to form, by this particular aggregation, a symmetrical figure of a regular shape, as will be mentioned in the following Note. These are indeed meer conjectures upon a subject, of which our own senses cannot bear the least testimony for our conviction. But it is easily conceived, that these regular shapes may be disturbed by various circumstances, and we find

be essential to salts, and by its varieties to mark out their different species, depends on an alkali, earth, and metals, united with more or less water: for otherwise, the crystals of alum and vitriol

find this to be the case with various salts, which are susceptible of different forms, although their constituent parts be really the same.

But when the watery fluid, in which salts are dissolved, happens to be driven off by a considerable violence of heat, they for the most part assume no crystalline form, but become a solid mass of a more or less granular texture, or of a glassy appearance, according to the nature of their constituent parts.

Metals are in the same case in regard to fire, as salts are to water: for when their particles are set into motion by the introduction of a large quantity of elementary fire, as soon as this substance disperses itself through the surrounding bodies, they become either a solid mass without any particular crystalline shape, if suddenly abandoned; or else they dispose themselves into symmetrical forms, and assume a regular shape, provided they be allowed to cool slowly enough, so that the partial attraction between the sides or ends of their constituent parts may be exerted. This evidently appears by the curious experiments of Mr. Mongez, who produced this new kind of crystals from almost all known metals, only by letting them cool after fusion, with a very slow gradation.

As to the fifth character of salts, viz. that of being *incombustible bodies*, as Dr. Cullen and Mr. Fourcroy assert, it seems by far a more difficult matter to settle: since Dr. Priestley found *volatil alkali* to be partly *inflammable*, and the same has been further confirmed, as Mr. Fourcroy mentions in a Note, by Mr. Cornette, who affirms it to be *very combustible*. Nor is it at all as yet demonstrated what Mr. Fourcroy pretends, viz. that salts are compound substances, formed by the union of some combustible bodies with *pure* or *dephlogisticated air*; from whence he concludes, that those formerly called *simple salts*, only deserve the name of *primitive*, as every one of them is in fact a true *compound*. But, although from the combustion of *sulphur*, *phosphorus*, and *arsenic*, acids of these denominations be produced, no similar results are found, as far

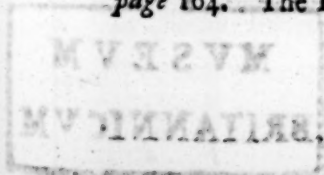
triol ought to be of the same figure; no *nitrum cubicum* would exist; nor could any crystallisation happen in such substances, as contain no acid. See Sect. 11. Note f. [b].

Salts are contained in all the three kingdoms of nature; and as it is not yet known how the changes happen, and how far the varieties depend on one another, we cannot attribute to the mineral kingdom any other salts

far as we know, after other combustions: and, until constant productions be the consequence of similar processes, it is quite unwarrantable to draw general conclusions. In fact it is well known that *acids* are found already formed, independently from any previous combustion; and that even *alkalies* exist already formed in plants before their incineration, as was mentioned Note a to Sect. 169, and Sect. 174. The Reader may see a good abstract of these and other new Theories, in a paper of Mr. de la Metherie inserted in the *Journal du Physique* for January 1786, and more fully in the *Elementary Lectures of Chemistry* by Mr. Fourcroy, already translated into English, with Notes, in 2 vols. 8vo. The Editor.

[b] Very little can be said, to good purpose, on the subject of crystallization; because no experiments have penetrated so far into the mysteries of nature, as to afford any demonstration of its cause. Whether the parts of bodies have a polarity with respect to each other, or whether their shapes may respectively be the cause of those admirably regular figures we often see in unorganized bodies, is uncertain: but it appears to be established beyond controversy, that all bodies whatsoever which become solid from a state of fluidity, have a disposition to assume certain peculiar symmetrical forms, or arrangements of their parts; though the variety of almost imperceptible impediments, arising from temperature and the due doses of parts, that, either designedly or accidentally, enter into the compound, makes it nearly impossible to bring the consideration of these figures to any practical use. See Note a to page 164. The Editor.

than



than those which are found truly changed in the earth [c].

The use of the salts in medicine and in common life is so great, that it would require a separate treatise, if it were to be fully discussed. Mean while, every one who applies himself to the study of mineralogy, in order to learn the use to which the mineral bodies can be employed in common life, I mean in particular that Miners ought to endeavour to discover where salts may be found, and how they must be prepared, so as to be best fit for use. But the preparation of salts is not the subject of this work; they are here only described, such as they are naturally found, viz. entangled in certain heterogeneous bodies, of which they require but very little for their saturation.

[c] I think it necessary to add a few words concerning the disposition I have followed in the Sections of this Second Class of mineral bodies. Various additions of new fossil salts having been discovered since the first publication of this work: I have arranged them in the same order, the late celebrated Professor Bergman made use of in his *Sciagraphia*, as far as the end of the Second Order, or Sect. 171.

But with regard to the compound salts of the following Sections, I thought it more regular to range each of them according to its base, by the same order as it stands in the preceding Sections of the *alkalis*, following at the same time the order of the acids already adopted in the first part of this class; or of the *earths* treated of in the first class of this Mineralogy; or lastly of the *metals*, as they are set forth by the Noble Author in the fourth or last class of this work. *The Editor.*

END OF THE FIRST VOLUME.



